THE OHIO JOURNAL OF SCIENCE

VOL. XXV JULY, 1925 No. 4

REPORT OF THE THIRTY-FIFTH ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The Thirty-fifth Annual Meeting of the Ohio Academy of Science was held at the College of Wooster, Wooster, April 3 and 4, 1925, under the Presidency of Dr. Edgar N. Transeau. Something over one hundred members registered as in attendance; forty-six new members were elected, making a total membership at the close of the meeting of 396.

GENERAL PROGRAM.

FRIDAY, APRIL 3.

9:30 A. M.—Business Meeting.
10:30 A. M.—Reading of Papers in General Session.
1:30 P. M.—The Invitation Address by Prof. C. G. Williams, Director Ohio Agricultural Experiment Station, Wooster, on "The Work of the Ohio Agricultural Experiment Station."
2:30 P. M.—Reading of Papers in Sectional Meetings.
6:30 P. M.—Annual Banquet, Kenarden Lodge, followed by an address of welcome by President C. F. Wishart of The College of Wooster.
8:00 P. M.—Address by President Transeau, Taylor Hall, on "Accumulation of Energy by Plants."

SATURDAY, APRIL 4.

8:00 A. M.—Adjourned Business Meeting.
9:00 A. M.—Reading of Papers in General Session.
10:30 A. M.—Inspection of Orchards and Horticultural Work at The Ohio Agricultural Experiment Station under leadership of Vice-President Secrest.
11:00 A. M.—Reading of Papers in Zoology Section and in Joint Session of Geology and Physical Sciences Sections.
1:30 P. M.—Field Trip to Forest Arboretum on Grounds of The Ohio Agricultural Experiment Station under the leadership of Vice-President Secrest, Botany Section.

Minutes of Business Meetings.

The first business session was called to order by President Transeau at 9:50 A. M., on Friday, April 3, 1925, in the Auditorium of Taylor Hall. An adjourned session was held at the same place at 8:00 A. M. on the following day.

The President announced the appointment of the following committees for the meeting:

Committee on Membership—Geo. D. Hubbard, Chas. H. Otis, Clifford R. Cutright.

Committee on Resolutions—L. B. Walton, J. H. Schaffner, Carl Ver Steeg.

Committee on Necrology—F. O. Grover, John A. Bownocker.

The following *Auditing Committee* was elected by the Academy: Lynds Jones and S. R. Williams.

The following *Nominating Committee* was elected by the Academy by ballot: Raymond C. Osburn, J. Ernest Carman, E. L. Fullmer, Samuel W. Chase, F. C. Dockeray, L. W. Taylor.

Report of the Secretary.

The following report by the Secretary was received and ordered filed.

Wooster, O., April 3, 1925.

To the Ohio Academy of Science:

The duties of the Secretary were, as in past years, largely of a purely routine character. These were taken care of with the greatest possible dispatch. Among the transactions that seem to be of sufficient importance to warrant their review at this time may be mentioned the following:

Certificates of election to fellowship in the Academy were sent to all those thus honored at the Annual Meeting in 1924.

A brief report of the Thirty-fourth Annual Meeting of the Academy and a copy of the report of the Committee on Necrology were sent to *Science;* the former appeared in the issue of May 23, 1924, pages 470–472.

Information regarding the history and organization of the Ohio Academy of Science together with a copy of our Constitution and By-Laws was sent to applicants in two or three states where the organization of an academy was under consideration.

The following letter received by the Secretary speaks for itself:

Toronto, Sunday, August 10, 1924.

Dear Mr. Alexander:

I do not wish to let today pass without telling you how much I am enjoying my visit here and how heartily I appreacite having been sent by the Academy.

There are quite a number of Ohioans here, so one could not feel strange. But if there were none, the easy, informal way in which things are planned and carried out prevents any shyness or stiffness. To me the meetings seem better organized than our own just from that very standpoint—but this is merely a personal opinion.

Academy members who are here include R. C. Osburn, F. C. Blake, Alpheus Smith, A. P. Weiss, E. L. Rice and his father from Conn. Wesleyan, B. W. Wells, who is now in North Carolina but who still is a member of the Academy, Dr. Clare Martin of Bowling Green, and Albert Shadle. There may be others but I have not run into them.

The botanists' meetings have been splendid; a good many excursions are planned. I was much surprised when out of a clear sky my name was called to take part in the opening discussion on movement of food and water in plants. The president evidently remembered me from my visit to England in 1921.

Sincerely,

A. E. WALLER.

In August, 1924, the Academy received a formal invitation to be represented at the inauguration of Robert Ernest Vinson, President of Western Reserve University, on October 9, 1924. Thereupon the Secretary wrote to Dr. Dayton C. Miller, Case School of Applied Science, Cleveland, asking him to serve as the duly accredited delegate of the Academy and he very kindly consented to do so. Doctor Miller's report follows:

CLEVELAND, O., Oct. 24, 1924.

Mr. W. H. Alexander, Secretary,
The Ohio Academy of Science, Columbus, Ohio.

MY DEAR MR. ALEXANDER:

In accordance with your appointment of October 1, 1924, I attended the inauguration of Robert E. Vinson as President of Western Reserve University on October 9, 1924. I registered officially as the Representative of *The Ohio Academy of Science* and signed the formal register of delegates. I attended the ceremony of inauguration and the banquet in this capacity, and expressed the greetings of *The Ohio Academy of Science* to the officials of the University.

I am enclosing a printed program of the exercises in which you will find *The Ohio Academy of Science* listed as participating in the occasion. I am sure the University appreciated the kindness and interest *The Ohio Academy of Science* took in this connection. With kindest regards, I am,

Yours very truly,

DAYTON C. MILLER.

The copy of the program sent by Doctor Miller is on file with the Secretary.

The Secretary was present to represent the Academy in the Council of the American Association for the Advancement of Science at the Washington, D. C., meeting. While there, the Secretary together with the Treasurer, participated in a conference of representatives from the various state academies called by Dr. Burton E. Livingston, Permanent Secretary of the A. A. A. S., for the purpose of going over and thrashing out the whole question of affiliation between the Association and the academies. We understand the Treasurer is prepared to give the Academy a complete digest of this whole matter together with a statement of the final action taken by Council of the A. A. A. S.

In December last, we received a letter from Mr. Ovid M. Butler, the Executive Secretary of The American Forestry Association, Washington, D. C., earnestly soliciting the endorsement of this Academy in an effort to secure through appropriate legislation National forest lands in

the Eastern half of the country. This matter is now presented to the Academy for its action.

In the last few days we have received a communication from one B. E. Skvirsky who, presumably, is speaking for the "Russian Information Bureau" in Washington, D. C., which, in turn, "is acting as representative of the Joint Information Bureau of Moscow in its endeavors to bring about closer contact between scientists as well as scientific and cultural organizations of the Soviet Union and the other countries." The communication was acknowledged and is now before the Academy.

Attention is also called to the fact that the Geology Section of this Academy held its annual field meeting and excursion in Cleveland and vicinity on May 30, 31 and June 1, 1924, under the leadership of Prof. J. E. Hyde of Western Reserve University. The committee composed of Vice-President Conrey, J. E. Carman and J. E. Hyde, prepared a most attractive program for this annual affair but we have no further report of same.

WILLIAM H. ALEXANDER, *Secretary.*

Report of the Treasurer for the Year 1924-1925.

The following report by the Treasurer was received and referred to the Auditing Committee whose report is appended:

To the Ohio Academy of Science:

The Treasurer submits the following report for the period from April 2, 1924, to March 13, 1925:

RECEIPTS.

Cash balance on hand	$ 554.73
Interest on certificate of deposit	39.00
Members dues paid through the A. A. A. S. and directly to the Treasurer	660.95
Total Receipts	$1,254.68

It is estimated that the library sales of publications will amount to $37.00, but a statement from Miss McKee is not available at this time.

DISBURSEMENTS.

To E. L. Rice, traveling expenses	$ 11.87
To Hotel Deshler, expenses for Dr. A. P. Mathews	12.00
To Wm. H. Alexander, honorarium	100.00
To A. E. Kraus	59.75
To B. E. Livingston	9.00
To B. E. Livingston	4.00
To A. E. Kraus	15.50
To A. E. Waller, traveling expenses to attend British Association meeting.	23.05
To Helen Coleman, stenographic assistance	7.34
To B. E. Livingston	7.00
To Wm. H. Alexander, secretarial expenses	23.16
To Delores Dehus, initial fee in A. A. A. S. remitted	5.00
To Esther Bearss, initial fee in A. A. A. S. remitted	5.00
To Schuler P. Hall, initial fee in A. A. A. S. remitted	5.00
To Helen Coleman, stenographic assistance	6.00
Total disbursements	$293.67
Cash balance on hand March 13, 1925	$961.01

CURRENT LIABILITIES (Estimated)

To the Ohio Journal of Science for each member's Journal subscription, approximately 320	$320.00
To honorarium for the Secretary, 1925	100.00
Printing and expenses of the 1925 meeting	100.00
Incidentals	40.00
Estimated total	$560.00
Estimated surplus for current year	$400.00

It is noted that the Academy will hereafter receive but half of the previous year's amount from the American Association. This will represent a loss of nearly one hundred dollars to the annual receipts. Since the Academy will send out its own statements there will be additional printing, postage and clerical assistance necessary.

It has been suggested that the Academy pay for a limited number of plates used in illustrating articles accepted by the editor for the Ohio Journal of Science. It has been expressed before in the Treasurer's reports that the Journal is the best place at our disposal for the expenditure of any small surplus the Academy may accumulate.

Respectfully submitted,

A. E. WALLER, *Treasurer.*

March 31, 1925.

Books, checks, vouchers submitted to the Auditing Committee and found to be correct.

LYNDS JONES,
S. R. WILLIAMS.

Report of the Executive Committee.

The following report of the Executive Committee was received and ordered filed:

WOOSTER, O., April 3, 1925.

To the Ohio Academy of Science:

A meeting of the Executive Committee was called by the President and was held at the Faculty Club Rooms, Ohio State University, Columbus, on December 20, 1924, with three members—Transeau, Waller and Alexander—present. Letters of regret were read from the other two members—Shatzer and Patten. President Transeau presided.

By unanimous vote it was decided to accept the invitation of the College of Wooster to hold the annual meeting for 1925 at Wooster, Ohio, and April 3 and 4 set for the meeting. The appointment of a local committee for the Wooster meeting was left to the President.

It was agreed that the preliminary announcements of the meeting should be issued not later than February 15 and that every effort should be made to obviate the conflict with the Educational Conferences held at the Ohio State University.

It was also agreed that in the event the Secretary was unable to attend the meetings of the A. A. A. S. at Washington, D. C., the latter

part of December, that the Treasurer, Dr. A. E. Waller, should be the representative of the Ohio Academy at a conference of representatives from the several state academies, called by Permanent Secretary Livingston, regarding the matter of affiliation.

It was further voted to recommend to the Academy the appointment of a permanent *Committee on Membership* at the Wooster meeting.

A second meeting of the committee was held last evening at Kenarden Lodge, College of Wooster, Wooster, Ohio, with three members present—Transeau, Waller and Alexander.

At this meeting twenty-seven applications for membership in the Academy were approved subject to final ratification by the Academy.

Respectfully submitted,

WILLIAM H. ALEXANDER, *Secretary,*
For the Committee.

Report of the Publications Committee.

The following report of the Publications Committee was received and ordered filed:

WOOSTER, O., April 3, 1925.

To the Ohio Academy of Science:

The Annual Report of the Thirty-fourth Meeting, Proceedings, Vol. VII, Part 9, contained 39 pages and was published in September, 1924. The report minus the membership list was also published in the *Ohio Journal of Science: 24:* 209–229, 1924.

Respectfully submitted,

H. C. SAMPSON, *Chairman.*

Report of the Library Committee.

The following report of the Library Committee was not received in time to be presented to the Academy but is published for the information of the members:

COLUMBUS, O., April 8, 1925.

MY DEAR MR. ALEXANDER:

I regret very much that pressure of work kept me from submitting to the Ohio Academy of Science the report of the Library Committee in time for reading at the Wooster meeting. I am inclosing the report of Miss McKee of the University Library who has attended to the details of the work this year. I suppose it will be possible for you to include this material in the regular section of the minutes just as if it had been presented at the meeting itself.

MISS MCKEE'S REPORT.

The sale of publications for the year amounted to $40.36, $2.62 of which is still outstanding, $37.74 having been turned over to the Treasurer of the Academy.

Late in December the Proceedings of the Thirty-fourth Annual Meeting were received from the printer and were mailed out in January to the members of the Academy and the exchange list.

Exchange publications received by the Academy have been filed in the Library, some additions having been made to the list this year and one or two that were interrupted by the European war have been revived recently.

ALICE D. MCKEE.

Respectfully submitted,

C. W. REEDER, *Chairman.*

Report of the Trustees of the Research Fund.

The following report of the Trustees of the Research Fund was received and ordered filed:

COLUMBUS, O., April 1, 1925.

To the Ohio Academy of Science:

The accounts of the research fund which came into our hands at the close of the last meeting, proved upon reference to the bank deposits, to amount to the sum of $1,324.82 as indicated in the Proceedings of the last annual meeting. $1,300.00 of this amount was put into 7% bonds, leaving a cash balance of $24.82. The addition of interest in November increased this to $1,362.91. Accrued interest due May 1st, will bring this amount to $1,407.41. There have been no bills submitted or paid which is in accordance with the instruction of the Academy, that the funds be conserved during the year and that the trustees recommend a plan of use for the fund in the future.

The question of how to best utilize the research fund, is a somewhat difficult one, but the trustees would suggest the following as a plan which may be subject to modification if the developments of the future indicate a better method.

We recommend that the income from $1,000.00 of the research fund be available each year for a grant to be known as the McMillin grant and which may be used either for the assistance in some research problem or given as an award in recognition of some especially noteworthy contribution of some member of the Academy. That the balance of the fund and income derived from it, shall be used or allowed to accumulate as the trustees may deem best in any particular year, it being understood that the fund or any interest income shall in all cases be used for the encouragement of research either by grants for individual problems or for the publication of papers resulting from research.

Respectfully submitted,

EDWARD L. RICE,
GEO. D. HUBBARD,
HERBERT OSBORN, *Chairman.*

Report of the Committee on State Parks and Conservation.

The following report of the Committee on State Parks and Conservation was received and ordered filed:

WOOSTER, O., April 1, 1925.

To the Ohio Academy of Science:

It was impracticable to have a meeting of the full committee, but the chairman has requested members of the committee to send him suggestions or remarks concerning the possibilities of work in the committee and has had replies from several members with varied suggestions. It is hoped that the committee may have a meeting in the future and formulate some definite suggestions concerning the management of the State Forest Areas, the Forest Parks and the Game Refuges, which are now under control of state authorities, and we believe that these areas offer a very practical means of preserving the State fauna and flora, and that with the cordial support of the authorities in charge of them, it would be possible to adopt measures which will furnish the most desirable conditions for the use of the parks as well as for the preservation of the native fauna and flora.

The most recent advancement has been the acquisition of a number of tracts for state forests and I cannot do better than quote a statement from Professor Secrest, the State Forester, and a member of this committee, concerning the progress in this line:

"The state department of Forestry was given authority by statute in 1916, to acquire lands for state forest purposes. The price of such land cannot exceed $10.00 per acre. In 1923 the state forest law was amended, permitting the Department to acquire 'areas of outstanding scenic value, virgin woodlands, and lands containing unusual flora.' In the purchase of such tracts the price is not limited by statute.

"From 1916 to 1921 it was difficult to secure funds for acquiring state forests. Increased appropriations from the Legislature were secured in 1921, and in 1923 were doubled, being $100,000 for the biennium.

"To date six state forests have been acquired totaling approximately 14,420 acres. These tracts comprise the Dean State Forest of 1,500 acres in Lawrence County; Waterloo State Forest, of 221 acres in Athens County; Scioto County State Forest, 5,200 acres, in Scioto County; Scioto Trail State Forest, of 5,900 acres in Ross County; Pike County State Forest, 1,100 acres in Pike County; and Mt. Logan State Forest of 500 acres in Ross County (under lease from Federal Government.)

"The state forests are located for the most part on 'absolute forest land,' and the tracts are to be devoted not only to experiments and demonstrations in timber culture, but to park and recreation uses as well. The present areas are in some cases nuclei to be further extended in the future. This is particularly true of Dean, Pike, and Scioto Forests. Land can be purchased within the limit of $10.00 per acre. The topography is rough, the soils thin, and the land largely stocked with second growth hardwood and pine forest. The open area is under 10%, and is in

most cases the typical abandoned fields, which when cultivation ceases are quick to revert to the typical Appalachian Plateau temporary forest types. About 300 acres of these old fields on the State Forests have been planted to a considerable variety of forest trees, which give promise for reforestation purposes. The forestry problems are largely those of protection against fires, and the management of the native forest stands. The State Forests are a delightful place for visitors who are interested in all forms of wild life, and the existing flora and fauna will be preserved and replenished by the protection now afforded these areas.

"The first forest parks were purchased in 1924. Logically enough the start was made in Hocking County where doubtless all will agree by and large Ohio's most outstanding, and interesting scenic areas exist. This is known as the 'cave region.' Not only is the geology most interesting, but the flora is decidedly varied, unique, and interesting. The gorges contain immense specimens of the original virgin woodland—hemlocks, tulip trees, oaks, maples, three species of birch, and a wealth of wild flowers.

"The well known Rock House, The Gulf or Old Man's Cave, and Kunkle's Hollow are now in possession of the State. An option has been secured on Ash Cave, and it can soon be taken over. Other interesting places in this region are contemplated for purchase.

"Other forest parks are under consideration in different parts of Ohio.

"The Parks will be open to the public under rules and regulations free of charge and arrangements will be made to provide accessibility and comfort to a degree that will satisfy those who love the outdoors, and nature's handiwork. The old fields in connection with the Parks, will be planted to trees so that the greatest usefulness will obtain.

"The State Forests and Forest Parks either purchased or under option now number 12, and total approximately 16,500 acres. The number and total area will be increased by July 1st with funds now available."

Professor Fullmer reports that there have been additions to the Cleveland Metropolitan Park System, which now consists of some 4,500 acres, and that "this is being added to from time to time and the opening of roads into some of the tracts has made them more available. It is planned to make a lake of some 100 acres on this portion of the tract near Whips's ledge. This tract lying about 15 miles south of the city in Medina County, has been enlarged by a gift since we visited it two years ago."

Professor Shatzer states that there is opportunity for the development of several miles of River Area Park in the vicinity of Springfield and that it is hoped this tract may be utilized.

The additions to the game refuges which are under the supervision of the Fish and Game Commission have not been reported recently, but while these do not give as permanent a guarantee of preservation as the State forests, they undoubtedly will serve a very valuable purpose, and the refuges which are permanent State property are being so administered that we believe they will prove of much value as biological centers.

The chairman of this committee visited the Royal Palm State Park of Florida last week and was much interested in learning as to its management. It is managed by the State Federation of Women's Clubs under authority of the State and maintains a lodge and provides picnic grounds for tourists, but with scrupulous care to preserve the natural conditions of a very unusual tract of biologic interest.

Respectfully submitted,

HERBERT OSBORN, *Chairman.*

Report of the Committee on Legislation.

WOOSTER, O., April 3, 1925.

To the Ohio Academy of Science:

Unfortunately the members of this committee are rather widely scattered over the State and it has been, therefore, practically impossible to get a quorum present for a formal meeting. A meeting was called for January 10, 1925, but a quorum did not appear. Thereupon the chairman of the committee called together a number of the members of the Academy living in Columbus and vicinity. At this conference were President Transeau, Professors Herbert Osborn, F. H. Krecker, and C. W. Reeder, and the chairman.

The only matter considered at this informal meeting was whether or not an attempt should be made to get a bill through the 86th General Assembly, and if so, in what form. It was agreed that we should make the effort and the following draft was worked out and submitted to the members of the committee:

H. B. No. 123.

A BILL

RELATIVE TO STATE RECOGNITION OF THE OHIO ACADEMY OF SCIENCE.

Be it enacted by the General Assembly of the State of Ohio:

SECTION 1. The Ohio Academy of Science, a corporation not for profit, incorporated under the laws of Ohio, March 12, 1892, shall be under the control of a board of trustees consisting of fifteen members to serve without salary or per diem. Six of the members of the board shall be appointed by the governor with the advice and consent of the Senate, two to serve for two years, two to serve for four years and two to serve for six years, and until their successors are appointed and qualified, and thereafter two members shall be appointed every two years to serve for a term of six years. The remaining nine members of the board shall be elected by the members of the Academy.

SEC. 2. On and after the taking effect of this act, the Ohio Academy of Science shall constitute an official source of advice and information on all scientific questions within its field submitted to it by any state department or officer thereof. The services of the Academy shall be available to the state or any of its officers in any matter within its field in which the consideration of scientific facts or policies may be involved, and the officers of the state may call upon the Academy of Science, through its properly elected officers or committees appointed by its officers, for such consultation and advice as may be of service to them in their duties. The members of such committees shall receive no compensation for their services, except that all traveling, clerical and other necessary expenses shall be paid. No member of the Ohio Academy of Science, while serving on any such committee, shall be eligible for expert service under advice from said committee for which compensation from the state is received.

SEC. 3. The Ohio Academy of Science may issue from time to time publications dealing with the results of scientific investigations. Through such agency or agencies as the board ot trustees may designate, said publications shall be made available by distribution, exchange, or sale, to the citizens of Ohio, scientific workers and scientific societies.

SEC. 4. The board of trustees shall submit biennially, to the director of finance, a budget covering the necessary expenses to be incurred in carrying out the provisions of this act, and the general assembly shall make such appropriations as it may deem advisable.

It was further agreed that in as much as Mr. E. J. Riggs of Gallia County introduced a similar bill at our request in the 85th Assembly (H. B. No. 400) he be asked to introduce the bill in the 86th Assembly. This he very kindly consented to do and the bill was introduced as drafted and became known as H. B. No. 123. It was referred to the Finance Committee and after considerable delay the committee gave us a hearing on the Bill. At this hearing appeared on behalf of the Academy, President Transeau, Mr. Arthur Harper, Mr. E. S. Thomas, Dr. R. C. Osburn and the Secretary. The hearing was respectful but purely perfunctory, as it was clearly evident that the Finance Committee had already closed the door against the Bill. The adverse decision of the committee announced a few days later was not a surprise.

The committee is of the opinion that if the Academy is to continue its efforts along this line—and it so recommends—and hopes to get results, it will be necessary for the Academy to resolve itself into a "committee of the whole" and make a united effort to interest the members of the Assembly through the "folks at home."

W. H. ALEXANDER *Chairman*,
EDWARD L. RICE,
L. B. WALTON.

Election of Officers and Committeemen.

The following officers and committeemen were duly elected by vote of the Academy upon the recommendation of the Nominating Committee:

President—Paul M. Rea, Cleveland Museum of Natural History, Cleveland.

Vice-Presidents:

Zoology—Clarence H. Kennedy, Ohio State University, Columbus.
Botany—W. Garfield Stover, Ohio State University, Columbus.
Geology—W. H. Shideler, Miami University, Oxford.
Psychology—Harold E. Burtt, Ohio State University, Columbus.
Medical Sciences—Dr. Samuel W. Chase, Cleveland.
Physical Sciences—Robert C. Gowdy, University of Cincinnati, Cincinnati.

Secretary—William H. Alexander, U. S. Weather Bureau, Columbus.
Treasurer—A. E. Waller, Ohio State University, Columbus.
Elective Members of Executive Committee—Lewis G. Westgate, Delaware; and M. E. Stickney, Granville.

Publication Committee—Henry C. Beardslee, Perry.
Trustee Research Fund—Geo. D. Hubbard, Oberlin.
Member Library Committee—E. L. Moseley, Bowling Green.
Committee on Legislation—Wm. H. Alexander, Columbus; M. M. Metcalf, Baltimore, Md.; Paul M. Rea, Cleveland; Edw. L. Rice, Delaware; L. B. Walton, Gambier.
Representatives on the Editorial Board of Ohio Journal of Science:
Zoology—R. A. Budington, Oberlin College, Oberlin.
Botany—Bruce Fink, Miami University, Oxford.
Geology—Wilber E. Stout, Ohio State University, Columbus.
Psychology—Erwin A. Esper, Ohio State University, Columbus.
Medical Sciences—F. C. Waite, Western Reserve University, Cleveland.
Physical Sciences—(Vacant).

Election of Members.

The following persons were regularly nominated and elected to membership in the Academy:

Blaydes, Glenn W.; Botany; 95 Oak Hill Ave., Delaware.
Bognar, E. J.; Geology; 1125 S. Seneca, Alliance.
Brown, Walter B.; Zoology, Anatomy, Physiology; Granville.
Bushnell, John; Botany; Ohio Agr. Exp. Station, Wooster.
Campbell, Robert J.; Botany, Entomology; O. S. U., Columbus.
Chase, John H.; Geology, Biology; 69 Benita Ave., Youngstown.
Cherry, Helen; Bacteriology, Geology; R. F. D. 1, Bellwood, Pa.
Clarke, Leota B.; Chemistry; 3103 12th St. N. W., Canton.
Copp, Paul T.; Mathematics; 233 Hartshorn St., Alliance.
Cutright, Clifford R.; Zoology, Entomology; Ohio Agr. Exp. Sta., Wooster.
Dike, Clyde E.; Botany; Ohio Agr. Exp. Sta., Wooster.
Diller, Jesse D.; Botany; 1501 Neil Ave., Columbus.
Dunn, Paul H.; Geology; Miami University, Oxford.
Frye, Walter; Geology; 209 Grand Ave., Akron.
Grady, Roy I.; Physical Sciences; 722 N. Bever St., Wooster.
Hay, Lloyd Q.; Biology, Physiology; North Industry.
Hersh, A. H.; Zoology; Adelbert College, W. R. U., Cleveland.
Howe, C. E.; Physical Sciences; 189 E. College St., Oberlin.
Howlett, Freeman S.; Horticulture; Ohio Agr. Exp. Sta.; Wooster.
Kuegle, Paul C.; Geology; R. F. D. 4, Loveland Road, Youngstown.
Lord, Richard C.; Physical Sciences (Chemistry); Gambier.
Miley, Hugh H.; Zoology; Miami University; Oxford.
Morgan, Mary S.; Forestry, Psychology; Astronomy; Girrard.
Nelsen, Olin E.; Microscopic Anatomy, Physiology; 335 Field Avenue, Toledo.
Palmer, Mary C.; Biology, Nature Study; R. F. D. 2, 760 Midlothian Road, Youngstown.
Poos, F. W.; Entomology; Box 283; Sandusky.
Price, John W.; Zoology; Pataskala.

ROTH, CONRAD; Birds, Wild Flowers, Forestry; 1715 Robinson Ave., Portsmouth.
ROWLES, EMMETT; Zoology, Medical Sciences; 97 Franklin Ave., Athens.
SCOTT, JOSEPH M.; Bacteriology, Animal Parasitology; 141 Simpson St., Alliance.
SCOTT, LUTHER C.; Geology; Toledo University, Toledo.
SPENCER, WARREN P.; Zoology; 138 N. Walnut; Wooster.
STEELE, MIDA L.; Botany; R. F. D., 1, Creston.
STEWART, GRACE A.; Geology; O. S. U., Columbus.
STINCHCOMB, G. A.; Physical Sciences; 138 Greenfield St., Tiffin.
SWENSON, ENGELBREKT A.; Physiology, Anatomy; W. R. U., Cleveland
TAYLOR, L. W.; Physical Sciences; 30 N. Pleasant St.; Oberlin.
TERWILLIGER, CHAS. VAN ORDEN; Physical Sciences; O. S. U., Columbus.
THIESSEN, NORMA W.; Chemistry, Biology; 1491 Lakeland Ave., Lakewood.
THOMPSON, OSCAR E.; Zoology, Botany; 42 Rice St., Alliance.
TRIESCHMANN, JACOB E.; Physical Sciences (Chemistry); 28 W. Davis St., Tiffin.
WATSON, S. A.; Biology; Wilmington College, Wilmington.
WESTHAFER, W. R.; ————; College of Wooster, Wooster.
WIEBE, ABRAHAM H.; Biology; Bluffton.
WILCOX, R. B.; Botany; Wooster.
WILLIAMS, C. G.; Physical Sciences; Ohio Agr. Exp. Station, Wooster.

Report of the Committee on the Election of Fellows.

WOOSTER, O., April 3, 1925.

To the Ohio Academy of Science:

A meeting of the Committee on the Election of Fellows was held last evening at Kenarden Lodge, College of Wooster, Wooster, Ohio. Six members of the committee were present and the other members were represented by proxy.

Of the candidates considered, two received the necessary nine favorable votes and were declared elected. The fellows elected will be personally notified, and the list will be published in the Proceedings of this meeting.

Respectfully submitted,

WILLIAM H. ALEXANDER, *Secretary,*
For the Committee.

The following is a list of those elected Fellows:

HENRY CURTIS BEARDSLEE
JOSEPH H. TODD

The following Special Report on the Relations between the American Association for the Advancement of Science and The Ohio Academy of Science was received and ordered filed:

WOOSTER, O., April 2, 1925.

To the Ohio Academy of Science:

The plans for affiliation between the American Association and the various state academies were made the subject of action at the St. Louis meeting of the Association in 1919. In January of 1920 your Treasurer was asked to inquire of Doctor L. O. Howard the results of this action and received the following reply:

"Yours of the 6th has come. I find that your understanding of the affiliation matter is correct and corresponds with the action of the Council at St. Louis, with the exception of No. 1. Following is a transcript from the minutes of the Council meeting of December 29th:

"The Committee on Affiliation of State and Local Academies reported the following recommendations:

"1. That State academies be affiliated on a financial basis that will yield the Association four dollars net per member.

"2. Any State academy which concludes arrangements for affiliation within the first six months of 1920 may be accepted for the entire year 1920, fees paid to the Association before that date to be adjusted in accordance with the detailed plan.

"3. Two alternative plans are considered with respect to membership in the academies, namely (a) All members of the academy to affiliate with the Association; (b) To establish two grades of membership, of which one will be national, involving membership in both academy and Association; the other local, consisting of academy membership only.

"4. The academies will collect joint dues and transmit the Association's share to the Treasurer.

"Voted that the report of the Committee on Affiliation of State and Local Academies be received and approved.

"Your No. 4 is all right. The collection of four dollars instead of three by the Association is necessitated by the new arrangement by which the Association pays the journal *Science* three dollars for each new member. You see we must have something for overhead expense."

It is clear from this letter that our Academy was not altering its dues, but that the Association was to receive one dollar less for the subscription to "Science" from all of its affiliated State Academy members. That this is plainly understood as the basis of the financial arrangement is still further brought out in a letter dated May 21 from Dr. B. E. Livingston, who succeeded Dr. Howard as Permanent Secretary of the Association:

"Replying to your several letters, your ideas about the nature of the affiliation between the Ohio Academy of Science and the American Association for the Advancement of Science are quite right. I think I have everything clear now.

We refund $1 for each member of the Academy who has paid $5 dues to the American Association for 1920. For each new member you are to send this office $4, together with his name and address and a statement of which journal he prefers. The journal will be ordered as soon as the remittance and data are at hand. Since back issues of the journals are limited, prompt action is necessary. Also, of course a new member would like to have his journal begin promptly. I suggest that you send me new members' names and remittance for them so that they will reach here on Wednesday of each week. We send our list to Science every Friday.

"I want to ask you if you can follow this scheme for collecting dues next October. We will have a special statement card prepared for Academies. On its front will be a statement of the affiliation and blank spaces for imprinting the Academy name and the bill for 1921 dues. On the back will be blanks to be filled in by members, for information for this office and for Membership List, A. A. A. S. We will put the name and address of member on front of card and send all cards to you. We will also supply window envelopes for you to mail cards out in. You are to send these out about September 25 or so and they are to come back to you, with members' remittances. You are to send the cards to this office with $4 for each one. This scheme will get your members on cards here which are just like the cards of our other members. I hope you will fall into this idea, for it is essential that we have the same system for all our members. A new membership list is being prepared and it is necessary that we have all the information about all members promptly after October 1."

It was not only clear from this that the Association was expecting to reduce the joint dues of members of both organizations, but also they were going to help in obtaining an increasing membership in the Academies.

After a year of this, however, the cost to the Association of remitting one dollar to each of its members who was also a member of a state Academy was greater than at first anticipated. In the correspondence of that period with Dr. Livingston, this amount lost to the Association by its voluntary relinquishment of one dollar of the price of the subscription to "Science" came to be regarded as money needlessly turned back to the individuals from whom it had been collected. From the point of view of State Academies which do not publish Journals or Proceedings of a scientific nature and whose membership fee had always been lower than ours in the Ohio Academy it was a clear gain of a dollar per member. Dr. Livingston wishing to call attention to what was undoubtedly great financial assistance to these Academies gave a name to the remitted funds and called them "*Grants of the Association to the Academies.*" It must be remembered however that in our Academy we had not changed our dues or our Journal costs. To us it was simply the arrangement originally proposed in the St. Louis meeting of the Association, namely—a reduction in the cost of *Science.* We did not see any reason for charging more for the *Ohio Journal of Science* for the members of the Association than for the Academy members who were not also Association members, and we simply returned the money to the former. Personally speaking I did not think that a mistake at the beginning of our affiliation and I do not think it a mistake now.

Correspondence was often voluminous over the manner of payments of the members and the affiliation arrangement for the past five years has been purely a financial arrangement from which no scientific benefits have accrued. As there were new plans evolved they would often come as "instructions" from the Association office. There was no way of obtaining a list from the Association of its members who were desirable from the standpoint of their attainments and residence in the State as prospective members of the Academy. We furnished the Association each year with the lists of our members. In 1923 the increases in enrollment in the Association through direct recommendation of the Treasurer were counted as seventeen. No account was taken at that time of the

total increases in Ohio. This was putting the increases in membership in an unfair light as undoubtedly the Academy members many of whom are science teachers and research students were largely responsible for these new memberships in the Association.

The Association after two years of having dues collected by the Treasurer in each of the affiliated Academies decided to collect its own dues. This seemed to your Treasurer psychologically unsound, as it meant that two bills in place of one must be collected from each member. The following paragraph is taken from a letter to Dr. Livingston written by the Treasurer under date of March 8, 1923:

"Your letter of February 23d which should have been sent to me was forwarded by Dr. Rice and reached me yesterday. You are doing the Ohio Academy of Science a great injustice in supposing that only seventeen new members were received through the Academy for the A. A. A. S. Our lists are not worth checking over on this point, but I know more than seventeen members have been added. You are doing the Academy a serious injury in changing the billing of the A. A. A. S. members from the office here to the Washington office because the members have just been trained to send the money here. Now your order (for that strong word is just about what it amounts to) comes, to abandon this system and substitute the collection directly through your office. Certainly the Academy can not be supposed to have been glad to collect the money for you in the first place. They did it simply as an accommodation and in the matter of the affiliation it seemed as though it would be an easy way of completing the arrangement."

With all of this there was still nothing but a financial arrangement and there was no scientific advance. There was further an annoying distinction made between the affiliated academies and the affiliated Societies which was also on a financial basis, namely that a five dollar initial fee was remitted if the new member was also a member of an affiliated Society. It was in consequnece difficult to find out exactly what a new member should pay.

Passing over the correspondence of the next year, we wish to note the work of Professor Osborn in attempting to raise the level of the basis of affiliation from an exchange of checks to the point where scientific work might be benefited. A paragraph from a letter of Dr. Transeau to Dr. Livingston under date of December 8, 1924, will serve:

"In view of the difficulties attending the collection and distribution of the dues, and the apparent change in point of view of the American Association indicated by a comparison of your letter with that of Dr. Howard, I would suggest that the proposal made by Professor Herbert Osborn might meet the situation. As I understand his scheme, it is that the dues be collected as before the affiliation, and that the Association actually subsidize the academies according to their membership, $25 for those having one hundred members or less, $50 for those having between one and two hundred members, and $100 for those having 300 or more members. These amounts would be credited to the Academy as a whole and would not be rebated to members. In this way the affiliation would not be weakened and the Association would not be called upon for any large contribution to the Academies."

This letter was written shortly before the Washington meeting of the Association. Through the Association's committee on State Academies and the letters from the affiliated academies registering protests to the secretary there was at the last meeting an attempt to come to an understanding and to bring our affiliation to a reasonable arrangement,

namely, to cost the Association less, but to derive more of scientific benefits from the work of the scientific men of the country. The Association has spent more money than it feels it should by reducing the price of *Science* to Academy members and is proposing a new and less expensive arrangement. It is contained in the following paragraphs:

(10) The Council adopted the following resolutions concerning the future of arrangements with affiliated academies of science and local branches:

(a) In view of the rapid increase in the number of members concerned, it has become impossible to continue the annual grants to affiliated academies and local branches as in the past, and the association consequently finds it necessary to reduce the allowances for these organizations, for 1926 and until further notice, to one-half of the present amount per member. This reduction is to go into effect October 1, 1925.

(b) All members of any affiliated academy are to be at all times, until further notice, eligible to admission to the association on certification by the proper academy officer and without payment of the usual entrance fee.

(c) The permanent secretary is instructed to take up the applications for academy affiliations according to the modified arrangements for academy affiliation now authorized.

5. Since the academy allowance from the Association is now to be but 50 cents per year per member, it seems desirable that the affiliated academies should collect full academy dues from their association members. It is hoped that those academies that have heretofore credited association allowances as academy dues will arrange this matter this spring, so that there may be no misunderstanding on the part of their members next fall when the new rule is to go into effect. It may be desirable for the proper academy officer to send to all association members of his academy an announcement on this subject, either before or at the time of sending out the bills for annual dues. The facilities of the permanent secretary's office are offered to the affiliated academies in this and similar kinds of circularization; multigraphing, mimeographing or printing circulars or letters and the addressing of envelopes for academy work can be cared for at the Washington office at actual cost or less, if the academy so desires. The general facilities of the office are to be at the service of the affiliated academies, with probably some saving in cost.

Since the arrangement between the American Association and the Academy has been largely a financial one, your Treasurer has cared for most of the correspondence. The Association promises for the future that the affiliation will have less of a financial and more of a scientific conscience. The association therefore asks the appointment of a representative from each of the State Academies. This is expressed in the recent communication under date of March 21, 1925, as follows:

REPRESENTATION OF AFFILIATED ACADEMIES IN THE ASSOCIATION.

D. Each affiliated academy is to have, as heretofore, a representative in the council of the Association, thus taking part in the direction of association affairs.

It is hoped that the academy representatives will be named as early in the year as possible, so as to be listed in the permanent secretary's files. If an academy representative is to be unable to attend an annual meeting of the Association another may at any time be named to take his place. In general, an academy representative will be considered as remaining in office until his successor is officially named to the permanent secretary's office.

It is suggested to the Ohio Academy that this representative be appointed as heretofore by the executive committee.

It cannot be denied that the Association has maintained a vacillating policy toward the State Academies. That this probably will continue is to be seen in the following paragraphs from the communications of March 21 from Dr. Livingston (italics inserted by the Treasurer).

G. *Term of these arrangements.*

"It is understood that those arrangements of academy affiliation are not to be considered as in any way binding on the Association beyond the actual statements here made. The arrangements here described are to go into effect October 1, 1925, *and are to be continued until further action by the council of the Association.* Modifications may be made from year to year and the nature of such modifications will doubtless be determined by the degree of success with which the purposes of the affiliation are fulfilled. It is understood, however, that no changes in the financial or membership aspect of these arrangements will be placed in operation without at least a six-months' preliminary notice to the academies. An academy may withdraw from the affiliation on six months' notice.

"*It is to be hoped that the affiliated academies will continue to increase in strength and that the time may soon come when they will not need to accept financial grants from the Association.* It is to be remembered that the source of academy allowances is solely the association membership dues paid by members and that there are before the Association many projects for advancing American science that will require funds from this source. If any affiliated academy may find it possible to remit its annual association grant such action will be greatly appreciated by the latter, the funds thus freed will be utilized to advance science in other ways, and the non-financial aspects of the affiliation may be strengthened by such remission of grants.

"The officers and representatives of the affiliated academies are invited to make further suggestions for improving the association-academy relations, and to inform the permanent secretary as to their approval or disapproval of the paragraphs of this memorandum, or as to their suggestions regarding the improvement."

A. E. WALLER, *Treasurer.*

April 2, 1925.

Following the reading of the above report, there was considerable discussion, pro et con, relative to the advisability of continuing the affiliation between the Ohio Academy of Science and the A. A. A. S. Finally, upon motion of L. B. Walton, seconded by R. V. Bangham, the matter was referred to the Executive Committee with power.

Report of the Committee on Resolutions.

The following resolutions were submitted by the Committee and unanimously adopted by the Academy:

1. The Ohio Academy of Science wishes to express its appreciation to *The College of Wooster*, The Ohio Agricultural Experiment Station and the unusually efficient local Committee, for making this, the Thirty-fifth Annual Meeting one of the most successful as well as enjoyable the Academy has held.

2. The Academy furthermore desires to extend to the representatives of the Press its cordial appreciation of the space given in the papers to the program and to the results accomplished by the members of this Academy.

3. The Ohio Academy of Science in session at Wooster, Ohio, wishes to place itself on record as deploring the recent action of the Governor and the Legislature of the State of Tennessee in connection with their recent enactments relative to natural phenomena. The publicity thus developed will prove disadvantageous to the best interests of the State.

4. The Ohio Academy of Science assembled at Wooster, Ohio, wishes to express its sympathy to the teachers of science in Tennessee in connection with the handicaps under which they have been placed in teaching the truths of nature.

L. B. Walton,
J. H. Schaffner,
Carl Ver Steeg,
Committee.

Report of the Committee on Necrology.

The Committee on Necrology records the loss by death during the year of four members, *viz.*:

Charles W. Napper, Greenfield;
Prof. A. D. Selby, Ohio Agricultural College, Wooster;
Prof. Septimus Sisson, Ohio State University, Columbus;
Prof. Herrick E. Wilson, Oberlin College, Oberlin.

Scientific Sessions.

The following is the complete scientific program of the meeting:

PRESIDENTIAL ADDRESS.

Accumulation of energy by plants.....Edgar N. Transeau

PUBLIC LECTURE

The work of the Ohio Agricultural Experiment Station.....C. G. Williams

PAPERS

1. Orchard Spraying and Human Health. (10 min.).....J. S. Houser
2. Local Lists of Plants and Animals. (20 min.).....Lynds Jones
3. Modern Ideas of Soil Development. (20 min.).....G. W. Conrey
4. Entomological Conditions in Cuba. (20 min.).....Herbert Osborn
5. A Biological Basis of Learning. (20 min.).....H. M. Johnson

6. Daily Life of the American Eagle; Early Phase (30 min.) (lantern)..... FRANCIS H. HERRICK
7. Relation of Temperature and Rainfall to Hessian Fly Development. (15 min.) (lantern).....H. A. GOSSARD
8. Seiches in Lake Erie and Their Ecological Significance. (20 min.) (lantern).....FREDERICK H. KRECKER
9. Repeated Rejuvenations in Hemp. (12 min.).....JOHN H. SCHAFFNER
10. The Dynamic Factor in Heredity. (12 min.).....A. B. PLOWMAN
11. Monocular and Binocular Vision. (15 min.).....PRENTICE REEVES
12. A Theory of Nerve Conduction and Its Application to Imagination and Habit. (15 min.).....N. M. JOHNSON
13. Intra-relationships of Echinoderms as Evidenced by Ciliation. (10 min.) (lantern).....R. A. BUDINGTON
14. The Relation of the Respiratory Exchange to Differentiation and Dedifferentiation in Obelia Sp. (10 min.).....EMMETT ROWLES
15. The Sexual Structures of Polydesmus Serratus. (10 min.).STEPHEN R. WILLIAMS
16. The Development of the Male Gonopods in Euryurus Erythropygus, Brandt; a Polydesmid Millipede. (10 min.).....HUGH H. MILEY
17. On the Structure of a Trematode of the Genus Eumegaceste Found in the Cloaca of the Common Tern at Put-in-Bay in 1924. (10 min.)..... JOSEPH N. MILLER

(Introduced by Prof. F. H. Krecker)

18. The Correlation of the Seasonal History of the European Corn Borer with Seasonal Planting of Corn. (5 min.) (lantern).....L. L. HUBER
19. Aphids New to Ohio. (By title).....C. C. CUTRIGHT
20. Some Reactions of Pemphigus Sp. (5 min.) (lantern).....C. C. CUTRIGHT
21. Exact Determination of Food Requirements in Bringing Insects to Maturity. (10 min.).....E. R. BRYANT
22. On the Anatomy of the Head and Thorax in Ranatra (Heteroptera). (10 min.) (lantern).....C. R. NEISWANDER
23. The Evolution of Insects Based on a Study of the Appendages. (10 min.) L. B. WALTON
24. A Biological Record and Classification Card. (5 min.).....L. B. WALTON
25. The Calorigenic Effect of Adrenalin. (15 min.).....M. W. CASKEY
26. Some Observations on the Architecture of the Spongiosa of the Calcaneus. (15 min.) (lantern) (See demonstration No. 1).....SAMUEL W. CHASE
27. Rickets and Osteoporosis in Swine as Affected by Nutrition. Dietary Factors. (15 min.) (lantern).....G. BOHSTEDT
28. Rickets and Osteoporosis in Swine as Affected by Nutrition. Pathology. (15 min.) (lantern).....B. H. EDGINGTON
29. The Effect of Light on Calcification of Bone. (15 min.) (lantern)..... R. M. BETHKE
30. Some Preliminary Notes on the Plankton of the Kartabo Region, British Guiana. (10 min.) (lantern).....HUGH M. RAUP
31. Some Factors Which Determine the Size of the Eye of Drosophila. (15 min.).....A. H. HERSH
32. A Note on Wing Venation in Certain Diptera. (5 min.) (lantern) JAMES S. HINE
33. Experiences and Experiments in Teaching Embryology. (10 min.)..... BRADLEY M. PATTEN
34. The Fauna of a Limestone Spring in Cliff Park, Springfield, Ohio. (10 min.) (lantern).....HUGH M. RAUP
35. The Relative Values of Morphological Adaptations. (10 min.)..... CLARENCE H. KENNEDY
36. Relation of Temperature to the Physiology of the Potato Plant. (15 min.) JOHN BUSHNELL
37. Some Abnormalities in Mnium. (10 min.).....CHAS. H. OTIS
38. Certain Aspects of the Chemical Composition of the Apple Flower. (12 min.).....FREEMAN S. HOWLETT
39. Lodging in Oats and Wheat. (15 min.).....F. A. WELTON
40. Variations in American Crab Apple (Malus Glaucescens, Rehder). (5 min.).....E. L. FULLMER

41. Some Factors Influencing the Development of Venturia Inequalis. (10 min.)..... H. C. Young
42. Degeneration of Potatoes in Ohio. (15 min.) (lantern)..... Paul E. Tilford
43. Effects of Lightning on the Trunk of Platenus Occidentalis. (5 min.).... John H. Schaffner
44. The Microchemistry of Flax Fiber Formation. (10 min.) (lantern)..... Donald B. Anderson
45. Some Fresh Water Algae from Fukien, China. (5 min.)..... L. H. Tiffany
46. Pre-Staining in Histological Technique. (10 min.)..... Chas. H. Otis
47. The Seasonal Development of Apple Scab in Central Ohio in 1924. (10 min.) (lantern)..... H. W. Johnson
48. The Genus Oedogonium. (15 min.)..... L. H. Tiffany
49. Experiments on the Control of Apple Scab in Central Ohio in 1924. (10 min. (lantern)..... W. G. Stover and H. W. Johnson
50. Some Mississippian Physiography of Northeastern Ohio. (25 min.)..... G. F. Lamb
51. Peneplains and Straths in Southern Ohio. (15 min.)..... Wilbur Stout
52. Peneplains in Muskingum County, Ohio. (10 min.)..... G. W. Conrey
53. The Uplands of Jefferson County, Ohio. (5 min.)..... R. E. Lamborn
54. A Method of Estimating Post-Glacial Time. (10 min.) (lantern)..... Allyn C. Swinnerton
55. Geologic Structures in Southern Vermont. (15 min.)..... Geo. D. Hubbard
56. Limestone Caves in Ohio (10 min.)..... Geo. W. White
57. The Areas of Distribution of Paleozoic Seas in the Arctic Regions of North America, Europe and Asia, in Connection with the Problem of Circumpolar Seas. (15 min.)..... Aug. F. Foerste
58. Difference in Niagaran Faunas Due to Development in Distinct Arms of the Sea, in Connection with the Cincinnati, Kankakee, LaSalle and Other Anticlines. (15 min.)..... Aug. F. Foerste
59. A Drag Fault. (8 min.)..... G. F. Lamb
60. Some Recent Deep Wells in Ohio. (15 min.)..... J. A. Bownocker
61. Dip and Expansion of Deep-seated Rocks in Eastern Ohio. (10 min.).... Wilbur Stout
62. The Members of the Monroe and their Distribution in Ohio. (15 min.)... J. Ernest Carman
63. Some Striking Features of the Lower Mercer Limestone in Mahoning County (8 min.) (Introduced by Prof. G. F. Lamb)..... Edwin J. Bognar
64. A Suggestion in Teaching Economic Geology. (5 min.)..... Geo. D. Hubbard
65. The Scrub Grass Coal in Ohio. (10 min.)..... Wilbur Stout
66. The Laws of Motion Under Constant Power (10 min.) (lantern) L. W. Taylor
67. A Precision Determination of the Acceleration of Gravity. (10 min.) (lantern)..... H. Hugh Willis
68. A Quantitative Measurement of the Change in Intensity in Radio Signals During the Transition from Daylight to Dark. (15 min.) (lantern)... C. E. Howe

DEMONSTRATIONS

1. Specimens to Illustrate Paper No. 26 ..... Samuel W. Chase
2. Grey Squirrel Killed by Excessive Growth of Incisor Teeth..... E. W. Schear
3. Drawings of Forster's Types of Odonata..... Clarence H. Kennedy
4. Iron Bacteria from Yellow Springs, Ohio. A. C. Swinnerton and O. L. Inman
5. The Mateer Embryo. Presomite Human Embryo-Twin. (Slides and Models)..... H. N. Mateer
6. One Cause of the Failure of Canada Thistles to Produce Seeds. Freda Detmers
7. Progress of the Common Barberry Eradication Campaign, 1918–1924.... John W. Baringer
8. Slides Showing Musculature of Appendages in Hexapoda..... L. B. Walton
9. Biological Record Cards..... L. B. Walton

THE INFLUENCE OF THE SUBSTRATUM ON THE PERCENTAGE OF SEX REVERSAL IN WINTER-GROWN HEMP.*

JOHN H. SCHAFFNER
Department of Botany, Ohio State University

In my paper on "The Influence of Relative Length of Daylight on the Reversal of Sex in Hemp" attention was called to the fact that apparently the substratum acts in inducing sex reversal along with relative length of the daily illumination period, by the following statement:† "A few experiments so far conducted seem to indicate that the percentage of reversal for any given length of daylight will be greater in a rich soil with abundant nitrogen than in a poor substratum low in nitrogen." Opportunity has not been available to test out completely the exact status of this observation. But it is apparently important to have a suitable substratum along with the proper length of daily illumination in order to obtain the expected sex reversal. The evidence so far obtained is, therefore, presented at the present time for the benefit of those who wish to carry on sex reversal investigations with the hemp (Cannabis sativa L.).

The highest percentages of reversal have been obtained when the hemp was planted in rich sandy loam with a rich supply of well-rotted cow manure, as stated in former papers. When hemp of the ordinary types is planted in such soil on shallow greenhouse benches with the ordinary greenhouse temperature and normal water supply, the percentage of plants showing sex reversal is roughly, inversely proportional to the relative length of daylight, ranging from 0% about the 15th of August, to 90% or over in December, to 0% again by the first of May. The reversal takes place in both directions about equally, although so far the staminate plants have shown a little higher reversal than the carpellate plants.

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* Papers from the Department of Botany, The Ohio State University, No. 153.
† Ecology 4:330. 1923.

The very highest reversal for carpellate plants was from two beds planted on December 19, 1919, as follows:

1st bed—Total carpellate individuals	18.	Showing reversal,	16
2nd bed— " " "	36	" "	32
Totals	54		48

Thus nearly 89% showed sex reversal. In a bed planted December 15, 1920, with 29 carpellate plants 25, or 86+%, showed reversal.

The highest reversal for staminate plants was obtained in two beds planted respectively on December 1 and December 15, 1920.

Planted Dec. 1—Total staminate individuals	66.	Showing reversal	62
Planted Dec. 15— " " "	42	" "	39
Totals	108		101

Approximately 93½% showed sex reversal.

On January 2, 1922, duplicate plantings were made by Mr. Donald B. Anderson, graduate student, in pure quartz sand and in pure well-rotted manure. This experiment was carried on for a different purpose but the writer had the opportunity of studying these plants for sex reversal. These plantings were in deep tin trays which were immersed in water kept at a temperature of 30–35° C. The plants in the sand were provided from time to time with the following nutrient solution which was decidedly deficient in nitrogen:

Purified calcium chloride ($CaCl_2$)—4 grams in 1000 cc. water.
C. P. potassium chloride (KCL) —1 gram in 1000 cc. water.
C. P. magnesium sulfate,
($Mg.SO_4+7H_2O$) —1 gram in 1000 cc. water.
C. P. potassium nitrate (KNO_3) —.5 gram in 1000 cc. water.

On account of the nature of Mr. Anderson's experiment, it was possible to study only the staminate plants.

1. Planted in pure manure with high moisture—total staminate plants 13; showing reversal 12, pure 1.
2. Planted in pure manure with low moisture—total staminate plants 19, showing reversal 14, pure 5.
3. Planted in quartz sand with low nutrition and high moisture—total staminate plants 20, showing reversal 10, pure 10.
4. Planted in quartz sand with low nutrition and low moisture—total staminate plants 18; showing reversal 9, pure 9.

There was some mortality among these plants before blooming, but apparently not much. The original seeds and seedlings had not been counted. In these experiments, therefore, the staminate plants which survived showed the following percentages of sex reversal:

Planted in manure—
Total staminate plants 32, of which 81¼% showed reversal to femaleness and only 18¾% remained pure.

Planted in sand—
Total staminate plants 38, of which only 50% showed reversal to femaleness and 50% remained pure.

In the autumn and winter of 1922, the writer continued the experiments, but used the ordinary, variable greenhouse temperature, the trays being kept on the benches. The same nutrient solution was used for the quartz sand cultures, and distilled water was used for watering. The manure used was apparently not rotted enough at the first planting date, which caused the carpellate plants to have poor root systems and to die before they came into bloom. For this reason the first planting of November 10 was discarded. The other plantings were as follows:

1. Planted December 2 in rich cow manure. Total staminate plants 15—showing reversal 12, or 80%; pure staminate 3, or 20%.
Carpellate plants not studied.

2. Planted December 2 in quartz sand. Total staminate plants 4—showing reversal 1, or 25%; pure staminate 3, or 75%. Total carpellate plants 9—showing reversal 0, or 0%; pure carpellate 9, or 100%.
There was a high mortality among these plants before they came into bloom.

3. Planted December 20 in rich cow manure. Total staminate plants 21—showing reversal 19, or 90+%; pure staminate 2, or 9+%.
Carpellate plants not studied.

4. Planted December 20 in quartz sand. Total staminate plants 12—showing reversal 3, or 25%; pure staminate 9, or 75%. Total carpellate plants 17—showing reversal 0, or 0%; pure carpellate plants 17, or 100%.

In all of these sand experiments there was considerable mortality; so if the plants that are capable of reversal under the given environment have a greater mortality than those which have a more persistent sexual state, the ratios would be somewhat modified. But this is not probable.

Taking into account the time of the year in which the planting was done the average reversal for the staminate plants should have been about 90% and for the carpellate plants about 83% if planted in rich, well manured soil. The plants in the pure manure approached these figures in spite of a rather high mortality in this substratum.

But the average reversal for the 34 staminate plants in the sand was only 33% and among the total of 26 carpellate plants in the sand cultures studied, there was no sex reversal whatever. Part of this result was probably due to the high mortality among the carpellate plants after they began to bloom and before the individuals had time to change their sex in any flower buds produced. It must be remembered that usually the great majority of carpellate plants are much more tardy in showing sex reversal than the staminate plants, and are, therefore, less favorable objects for study, when grown in very sterile soils, than the staminate plants.

As stated above, the 68 staminate plants grown to maturity in the pure manure cultures showed nearly 84% reversal to femaleness, approximating the 90% or more usually obtained when the plants are grown on the greenhouse benches in well manured sandy loam at the same season of the year.

It is thus evident that although a primary cause of sex reversal in hemp is the relative length of daylight and darkness during the 24 hours, the percentage of reversal and even the very possibility of reversal depends to a considerable extent on whether the plant is drawing the proper nutrients, especially nitrogen, from the substratum at the time.

The reversal of sex is probably brought about by a physiological condition dependent in some way on the carbohydrate-nitrogen ratio in the cells. Gardner* in his studies in the nutrition of bisporangiate strawberries (Senator Dunlap) as related to yield, came to the following conclusions in regard to the sex development and reversal which appeared in his cultures: "Low carbohydrate and low starch content at the time of fruit bud differentiation led to the production of female flowers in a variety that normally is hermaphroditic." "It is suggested that variations in the relative carbohydrate content are responsible for changes in sex development, low carbohydrate content

* Gardner, V. R. Studies in the Nutrition of the Strawberry. Univ. of Missouri Agr. Sta. Research Bull. 57:1-32, March, 1923.

being associated with the female condition, high carbohydrate content with hermaphroditism." This of course might be true for the bisporangiate-flowered strawberries and not necessarily for other types of plants.

Apparently the Senator Dunlap Strawberry, Arisaema triphyllum (L.) Torr., and Cannabis sativa L. are each good species for studying the relation that may exist between the substratum, the carbohydrate-nitrogen ratio of the protoplast, and the sex determination and sex reversal that occur so readily with the proper environment in these plants. Physiological ecology must soon take its place as a fertile field of research among its sister divisions in the botanical field if we are to obtain a better understanding of the great and fundamental problems presented by living things.

OHIO MOSSES, POLYTRICHIALES*

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Among the students of Ohio mosses, most of whose work was done a number of years ago, may be mentioned William S. Sullivant, Leo Lesquereux, H. C. Beardslee, W. C. Werner, A. P. Morgan, Miss H. J. Biddlecome, W. A. Kellerman and Edo Claassen. The last named has made a rather extensive study of the mosses of northern Ohio. About 250 species of mosses have heretofore been reported from Ohio and there may be many more not yet reported. This is exclusive of the Sphagnums. Otto E. Jennings has made an extensive study of the mosses of western Pennsylvania and his work is of great value in a study of the Ohio mosses, as many of the species listed in his publications are found also in Ohio. So far as the writer knows, no special or complete study of the Ohio mosses has been made. The present paper is a preliminary study of the order Polytrichiales. The nomenclature used agrees with the law of priority and where characteristics could not be verified from the specimens themselves, only those have been used which are noted by all authors as being fixed. For identification both the gametophyte and the sporophyte have been used as the keys have been constructed so that identification could be made with the use of only a hand lens. To make the identification from the gametophytes alone sections and a compound microscope would be necessary. The distribution indicated for each species is based on specimens in the Ohio State Herbarium unless otherwise indicated.

At the suggestion of Professor John H. Schaffner, under whom this work was carried on, the terms perigonium and perigonial scales are used for both the archegonial and antheridial branches.

Polytrichales.

Mostly unisexual mosses, acrocarpous, ours mostly little or not at all branched, rising either directly from the protomema or from a subterranean rhizome-like stalk. Sporangium with a definite columnella.

* Papers from the Department of Botany, the Ohio State University, No. 156.

Peristome teeth solid, single, or double, or rarely absent. Always present in our species. Teeth are developed from two layers of the sporangium, and consist of entire cells; not transversely barred; or if developed from the thickened parts of the cell walls, then the sporangium is decidedly dorsiventral.

Synopsis of the Order.

I. Peristome of 4–6 teeth; sporangium erect, actinomorphic; small mosses. (Tetraphidaceæ). Tetraphis. (1) pellucida.
II. Peristome of numerous teeth; sporangium actinomorphic or zygomorphic.
  A. Sporangium actinomorphic; gametophytes large. (Polytrichaceæ).
    1. Calptra smooth. Catharinea (2) crispa, (3) angustata, (4) papillosa, (5) plurilamellata, (6) undulata.
    2. Calyptra hairy.
      a. Sporangium cylindrical. Pogonatum. (7) pennsylvanicum.
      b. Sporangium angled. Polytrichum. (8) ohioensis, (9) gracile, (10) commune, (11) juniperinum, (12) alpestre, (13) piliferum.
  B. Sporangium zygomorphic, gametophytes small. (Buxbaumiaceæ).
    1. Sporangium only slightly zygomorphic, nearly sessile; scales present. Diphyscum. (14) foliosum.
    2. Sporangium decidedly flattened and dersiventrally differentiated; with a short seta; scales disappearing entirely. Buxbaumia. (15) aphylla.

Key to the Families of Polytrichales.

1. Peristome teeth 4–6, sporangium actinomorphic; small mosses. Tetraphidaceæ.
1. Peristome teeth 32–64, sporangium actinomorphic or zygomorphic. 2.
2. Sporangium actinomorphic; large mosses. Polytrichaceæ.
2. Sporangium zygomorphic; gametophyte very small. Buxbaumiaceæ.

Tetraphidaceae.

Gametophytes small and gregarious, forming dense mats. Scales ovate or lanceolate, smooth, margins entire, costa extending nearly to the tip. Peristome of four solid teeth formed from all the tissue enclosed within the operculum. Sporangium cylindrical, smooth, erect; hypophysis tapering, no stomata.

1. *Tetraphis* Hedw. (Georgia Ehrh.)

Gametophytes slender, brownish, branched, stalks 3-angled, gemmæ borne at tip of branches in a cup formed of four or five broad scales.

1. *Tetraphis pellùcida* (L.) Hedw. (Georgia pellucida Rabenhorst). Gametophytes forming yellowish-green tufts, brownish below, one-half to one inch tall, branches of two kinds, those bearing stalked gemmæ and the fertile branches which occasionally bear two sporophytes. Seta straight, slender, brown, one-half to three-fourths inch long; sporangium slender, erect; calyptra covering the upper one-third. Spores mature in late summer, but the capsules persist through the winter. Found on decaying wood, or in swamps on soil rich in organic matter.

This is the only common moss having the 4 peristome teeth. Specimens from Fairfield, Champaign, and Lawrence Counties. Reported from Cuyahoga, Portage, and Summit.

Polytrichaceae.

Large mosses growing mostly on the soil, cespitose; branches simple or branched, from a rhizome. Upper scales large, clasping, lanceolate or ligulate, with the ventral surface bearing few to numerous lamellæ one cell in thickness and several cells high. Lower scales much smaller and not lamellate. Antheridia borne in a large discoid cup at the tip of a branch which may later renew its growth. Seta long; sporangium erect, later becoming inclined or pendulous. Peristome teeth numerous, short, attached by their tips to the expanded top of the columnella. Calyptra cucullate.

1. Calyptra smooth.....Catharinea.
1. Calyptra hairy. 2.
2. Sporangium cylindrical.....Pogonatum.
2. Sporangium 4–6 angled.....Polytrichum.

1. *Catharínea* Ehrh. (Atrichum Beauv.)

Scales crisped when dry, margins serrate, not sheathing the stalk. Sporangium smooth, cylindrical or oval, more or less curved. Calyptra without hairs, but is spinulose-papillose at the apex. Operculum long-beaked. Peristome teeth 32, with a rust-colored median line.

1. Scales oval-oblong; lamellæ 1–4, low and indistinct; sporangia obconical, C. crispa.
1. Scales ligulate. 2.
2. Sporangia strongly arcuate, cylindrical.....C. undulata.
2. Sporangia inclined, oblong.....C. angustata.

1. *Catharinea crîspa* James. (Atrichum crispum Sull.). Gametophytes form yellowish-green tufts; stalks unbranched, 2–4 inches high; scales distant, oval-oblong or oblong-lanceolate, lamellæ 1–4, low, vanishing toward base of scale, scarcely undulate; lower scales smaller and broader. Often two or three sporophytes grow together. Sporangia only slightly curved, obconical.

Rare. Found in beds and on sides of rocky streams, in sand or among grass. Clinton County.

2. *Catharinea undulàte* (L.) Weber and Mohr. (Bryum undulatum L., Atrichum undulatum Beauv.). Gametophytes in loose, dark green patches, yellowish when in open dry spots.Stalks simple or branched from a much branched rhizome, 1–2 inches tall. Scales very small below, gradually larger above; upper ones ligulate, strongly undulate; lamellæ 2–6, covering one-eighth to one-fourth of the width of the upper part of scale. Sporophytes often two or more from one perigonium; seta reddish-brown, 1–1¼ in. long; sporangium strongly arcuate, cylindrical.

A common moss on shady clay or sandy banks.

3. *Catharinea angustàta* (Bridel.) Bridel. (Polytrichum angustatum Schw., Atrichum angustatum, B. & S.). Loosely cespitose, dull green, one-third to one inch tall. Scales linear-lanceolate, lamellæ and costa

occupying more than one-fourth width of scale; lower scales minute. Seta erect, brown; sporangium brown, linear, cylindrical, slightly curved. On shady banks, often under hemlocks.

Rather general in Ohio.

Jennings has described two new species found in Western Pennsylvania and these are probably found in Ohio. They vary from *C. angustata* only in the number and height of the lamellæ and may be forms of *C. angustata*. They are distinguished as follows:

C. angustata—Lamellæ 5–8, 6–8 cells high, covering one-fourth to one-half of upper scale width.
C. papillòsa Jenn.—Lamellæ 6–8, 8–14 cells high, covering one-half to two-thirds of upper scale width.
C. plurilamellàta Jenn.—Lamellæ 7–12, 8–14 cells high, covering two-thirds to three-fifths of upper scale width.

2. *Pogonàtum* Beauv.

Gametophytes gregarious, erect, upper scales somewhat clasping. Sporangium erect, cylindrical, without stomata, hypophysis tapering. Calyptra mitrate, densely hirsute and somewhat shaggy, hairs covering the entire sporangium. Peristome teeth, 32.

1. *Pogonatum pennsylvànicum* (Hedw.) Paris. (Polytrichum pennsylvanicum Hedw., Pogonatum brevicaule Beauv., Pogonatum tenue F. G. Briton, Polytrichum tenue Menzies). Gametophytes scattered on a green felt-like protonema, very short, less than one-eighth inch. Scales acuminate, serrulate, lamellate. Seta yellowish or reddish; Calyptra light yellow; operculum beaked. On shady clay banks. Fruits in late autumn.

Specimens from Franklin and Lawrence Counties, and Claassen reports it from Cuyahoga and Lake.

3. *Polytrichum* Dill. Haircap Mosses.

The largest of our mosses, tufted, stiff, green or bluish-green. Scales not sheathing, lamellæ and costa occupying the greater part of the outer part of scales; costa often extending in an awn. Sporangium 4–6-angled, cubic to oblong. Calyptra covered with dense shaggy hairs which extend below base of capsule. Generally 64 peristome teeth.

1. Margins of scales broad, entire, and inflexed. 3.
1. Margins of scales serrate, not inflexed. 2.
2. Hypophysis with constriction above, disk-like; sporangium cubical, with short beak.....P. commune.
2. Hypophysis not constricted above; sporangium longer than broad, P. ohioensis.
3. Costa ex current,forming a long hyaline awn, rough; plants small and simple, in dry places.....P. piliferum.
3. Costa only slightly or not at all excurrent, red; plants larger. 4.
4. Stalks densely tomentose below; sporangium cubic; scales erect..P. alpestre.
4. Stalks not at all or only slightly tomentose; sporangia oblong; scales spreading.....P. juniperinum.

1. *Polytrichum ohioénsis* Ren. and Cand. Ohio Hair-cap. Loosely cespitose, olive-green, gametophytes erect; 1–6 inches tall; stalks stiff, brown. Upper scales sheathing, spreading when moist, costate, 40–50 lamellæ. Sporophyte erect, seta brown, 1½–2½ inches long; sporangium erect when young, becoming inclined when older, elongated, slender; tapering, not constricted above, hypophysis calyptra not covering sporangium; operculum long-beaked. Spores ripe in June. Common; in moist, shady places.

Polytrichum grácile Dicks, is a form very similar to *P. ohioensis* and doubtless often confused with it. The characteristics of the two as described overlap and are variable. The terminal cell of the lamellæ of *P. gracile* in cross-section is rounded, while that of *P. ohioensis* is notched.

2. *Polytrichum commùne* L. Common Hair-cap. Gametophytes similar to *P. ohioensis*, but larger, 6–18 inches, our largest moss. Seta 2½–4 inches long, brown. Sporangium almost cubic; hypophysis distinct, constricted above, operculum with a short beak; calyptra light yellow, extending to below the sporangium. Spores mature in mid-summer. In open fields or woods.

Williams and Licking counties. Claassen reports it from Cuyahoga, Geauga, Lake, and Portage.

3. *Polytrichum junipérinum* Willd. Juniper Hair-cap. Plants scattered, erect, 1–4 inches, light green, slightly tomentose at the base. Scales lanceolate, sheathing, inflexed, entire, spreading when moist, costa excurrent to form a short dentate, red arista; lamellæ 35–40. Seta 1½–2½ inches long, red; sporangium tetragional-oblong, sharply angled, operculum red with a short beak, hypophysis rather indistinct. Spores mature in mid-summer. In dry pastures or open woods.

Rather common.

4. *Polytrichum alpéstre* Hoppe. (Polytrichum strictum Banks). Resembles *P. juniperium*, except it grows in dense matted tufts, grayish-white tomentose; slender, terete, up to one foot tall. Scales entire, erect, sheathing; costa protruding to form a red, serrate arista; lamellæ 25–30. Seta 1½–2½ in. long; sporangium cubic brown; hypophysis distinct; calyptra covering the capsule; operculum flat. Spores mature in mid-summer. Bogs.

Has not been reported from Ohio, but may be present as Jennings lists it from western Pennsylvania.

5. *Polytrichum piliferum* Schreb. Loosely tufted, light green, somewhat glaucous. Gametophytes simple, erect, 1–1½ inches tall; scales only on the upper part of the stalk, ascending when moist, lanceolate, entire, margins inflexed, ending in a long, hyaline, white awn.

Seta 1–1½ inches long; sporangium sharply 4-angled, usually horizontal when mature; hypophysis constricted above; operculum with a short beak, stout; capytra covering the sporangium. Spores mature in midsummer. On dry, sandy soil or rocky ledges.

No specimens, but is reported by Kellerman.

Buxabaumiaceae.

Very small mosses with the protonema often persistent. Sporangium zygomorphic, oblique and dorsiventrally asymmetrical, very large in proportion to the remainder of the plant; calyptra very small; peristome of one or two layers, outer teeth, when present, very faintly barred.

1. Scales persistent, exceeding the sporophyte in length; seta almost or quite absent.....Diphyscum.
1. Scales deciduous; seta distinct.....Buxbaumia.

1. *Diphyscum* Mohr.

Low, gregarious perennials with a long, persistent protonema. Scales dense, spreading when moist, ligulate or lanceolate, entire; perigonial scales longer, erect, membraneous; costa long aristate. Seta very short; sporangium immersed, mouth very small.

1. *Diphyscum foliòsum* (Webr.) Mohr. (Webera sessilis Lind., Buxbaumia foliosa Weber). Plants form a dense dark green mat; many sterile plants. Seta almost or entirely absent, sporangium light brown, resembling a grain of wheat, apex curved, pointed; inner peristome white, later brown. Found on moist clay banks where there is little or no other vegetation, and usually associated with a white lichen.

Reported by Claassen from Cuyahoga County.

2. *Buxbaùmia* Haller.

Antheridial plants microscopic, having a single scale enclosing one stalked antheridium; archegonial plants with only a few minute, deciduous scales, without chlorophyll. Seta rough, stout; sporangium conspicuous, oblique, dorsiventral.

1. *Buxbaumia aphylla* L. Protonema persistent, forming a brownish mat. Seta purplish, about one-half inch long; sporangium glossy, brown, almost horizontal, flattened above. Spores scattered by the splitting of the capsule. Capytra minute; perisome present. On ground or rotten wood. Spores mature in late fall and early spring. Rare.

Perry County. Is also reported from Jacob's Ladder, Fairfield County, by Miss Clara G. Mark.

SYNAPSIS CONSIDERED AS A SEXUAL PHENOMENON.*

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The first decade of the 20th century witnessed the establishment of the theory of the individuality of the chromosome, through numerous cytological investigations, on a firm basis of fact. The acceptance of this deduction had and still has a most profound influence on biological theory. The discovery by Montgomery (8) and others that the bivalent chromosome is actually made up of a pair of univalents, one from the maternal and one from the paternal side, laid the cytological basis on which genetics can be substantially built. But in recent years it has been found that many irregularities in conjugation and segregation occur, which shows that the properties of the chromosomes that cause them to unite and separate are properties that may appear and disappear regularly or irregularly in the life cycle. This property of specific attraction at a single special point in the life cycle is appropriately considered as a second development of primary sexual states, the first being in the gametes themselves. The specificity of the chromosomes in relation to synaptic attraction is far more remarkable then the fact of individuality of material and form.

Most cytologists have been impressed by the peculiarities of the reduction division. But the reduction division shows no special deviation from ordinary vegetative karyokinesis except as it is modified by the synaptic properties of the chromosomes during the prophase and metaphase stages. The writer worked out the details of the reduction division long before he knew what relation these chromosome shiftings had to heredity or what the actual probable cause was for the peculiar deviations from the vegetative divisions. (10). Several re-examinations of the original materials have reassured him that his first interpretation of the figures was essentially correct, and gave the proper basis also for the later developed facts of Mendelian heredity.

* Papers from the Department of Botany, The Ohio State University. No. 160.

A comparison of the sexual conjugations of gametes with the conjugations of synaptic pairs of chromosomes shows that the phenomena are alike in many respects and tends decidedly to the conclusion that the synapsis of specific pairs of chromosomes is due to the presence in them of primary sexual states of the same nature as the primary sexual states of the entire protoplasts, including their nuclei, i. e., of gametes, and which cause them to be attracted to each other and thus associated during the diploid stage of the organism. Just as there is more or less specific compatibility or indifference in the conjugation of gametes so also is there a specific compatibility or aversion of chromosomes of the same set to conjugate or of different sets in the case of extreme hybrids. The characteristics and peculiarities of isogamous gametes and the various degrees of heterogamous gametes are also paralleled to a certain extent although not entirely by the evolution of allosomes in some organisms. From this point of view a sexual organism has two stages in its life cycle in which primary sexual states arise. In one stage (gamete stage) the entire protoplast, but more especially the entire nucleus, which is normally haploid, becomes + or − in relation to another protoplast; in the other stage (reduction or synapsis stage) the chromosomes become + or − in relation to each other individually, without any special reference as to whether the sporocytes are for the time being in the secondary male or female state, namely are microsporocytes or megasporocytes, or are in a neutral condition as for example in homosporous plants. This sexual union of synaptic mates was suggested in a general way in 1908 but up to the present has not been developed further by the writer. (Schaffner 13).

In case of polyplody the normal sequence of events may, of course, be considerably changed. Belling found that in triploid Cannas (1) the three chromosomes of each kind or set come together. Multiple conjugation of chromosomes is possible just as triple fusion or other multiple fusions of nuclei in the gametophytes of Angiosperms.

In many species synapsis first becomes manifest by the development of the protochromosomes. In this early stage evidently the individual chromosomes must be attracted into their appropriate synaptic pairs and in the ordinary types of karyokinesis this is the only time when such proper association

is possible; and we know that the chromosomes are properly paired off both from the consequent Mendelian behavior and from direct cytological evidence as first definitely shown by Montgomery (8). Were there no cytological evidence for the individuality of the chromosome and for definite synaptic mates we would be compelled by the genetic evidence to hypothecate such a condition in spite of the so-called crossing over of hereditary factors. But the evidence for individuality and specific, synaptic mating in normal reductions is convincing. The genetic evidence properly interpreted and the cytological evidence are in accord. The peculiar notion of a parasynapsis by which two complete threads each made up of a chain of chromosomes, are supposed to come to lie side by side for the entire length of the chain during synizesis requires a mechanism and activity of the chromatin entirely outside the method of behavior of the nucleus in the vegetative karyokinesis.

The first division of meiosis or the true reducing division proceeds then along the same lines as an ordinary nuclear division except that the pairs of chromosomes become sexualized in relation to each other and are associated first as protochromosomes. From this stage on they elongate, join end to end in a continuous chain as in any vegetative division, and produce a thread with a single row of chromatin granules which later divide and form the double spirem. It is this enlarged state of the nucleus with its extended and delicate, continuous thread that shows synizesis in ordinary microscopic preparations. At the stage when the spirem has the double row of chromatin granules and when it is much thicker there is usually no synizesis unless the material has been very poorly killed. The sexual attraction continues very strong between the synaptic mates, holding them in telo-synapsis at the point of union of the pairs much more strongly than the union with the next pair in the skein, as shown by the subsequent behavior. After the forces which produce the extended spirem and which apparently act in opposition to the synaptic attraction are expended and the spirem is shortening and developing the chromatin loops the synaptic attraction again acts very strongly and throws the mates into longitudinal often twisted loops or fold, into the true para-synaptic position. Next the force that has held the chromosomes together in a continuous chain disappears just as in a vegetative division and the chromosomes fall apart except

at the ends where the pairs were originally held together in telosynapsis in addition to the ordinary union. The sexuality of the synaptic mates becomes much intensified at this stage resulting in such a close union of the bivalents and their daughter halves that they usually appear like single chromosomes. But just as the primary sexual state disappears in the united gametes when the nuclei have fused so the synaptic mates lose their + and − condition and by the time they have been brought into the mother star with the spindle fibers properly attached, they normally become promptly and completely desexualized and are separated to the opposite poles much like daughter chromosomes are in vegetative karyokinesis, except that each univalent is made up of two longitudinal daughter halves as it arrives at the pole. However, sometimes the attraction continues beyond the usual stage in some synaptic pair, resulting in irregular chromosome distributions. The sexual state of the synaptic mates may also disappear too early, again making abnormal distributions possible. As indicated, the segregated univalents are already in the longitudinally divided condition and this probably is the cause of the prompt development of the second spindle, often before the nucleus has advanced very far toward the resting condition. The second division of meiosis is, therefore, a necessary consequence of the modification of the karyokinesis brought about by the synapsis of the chromosomes in the first division.

The reduction division is then an ordinary division modified by the development of primary sexual states in the individual chromosomes, leading them into synapsis and there is apparently nothing peculiar in the reduction division except what is consequent to the sexualization of the synaptic mates. There is nothing mysterious in the reduction division itself but, as Strassburger pointed out long ago, it is a necessary consequence of fertilization if a sexual organism is to perpetuate a working or workable mechanism. The mystery at present lies with the sexual states, both primary and secondary. The important peculiarities which are the result of sexualization are first, the concentrations and movements of the chromatin giving rise to the protochrosomes, often rather definite masses; second, the strong bond of union in telosynapsis of the synaptic mates; and third the further attractive process at the looping stage by which the two fused chromosomes are drawn together in a close

lateral union or parasynapsis, which for a time may entirely obliterate any indication of the actual duality of the structure.

Karyokimeses in which there is no sexualization of the chromosomes, whether taking place with haploid, diploid, triploid, or tetraploid complements of chromosomes are essentially the same in character. But the presence of a multiple set or complement of chromosomes greater than diploid must necessarily give rise to possible new Mendelian ratios or to abnormal deviations.

The writer first discovered the important processes in the reduction division in Lilium philadelphicum (10) in 1897, and later in Erythronium in 1901 (11), in Lilium tigrinum in 1906 (12), and in Agave virginica in 1908 (13). In 1905 Mottier (9) found the process essentially the same in Podophyllum peltatum; and Miss McAvoy's study of Fuchsia (6) and of Oenothera biennis in 1913 (7) showed that a similar succession of stages was present in these species, and not merely a telosynapsis as reported for "Lamarckiana" mutants by Gates (3 and 4) and others. From 1903 on a large number of investigators, especially Farmer and Moore (15), confirmed the earlier conclusions. DaCruz (2) found a very beautiful series of figures in Lilium tenuifolium. In the meantime the "parasynaptists" were writing another story. But any one acquainted with the cytology of the higher plants knows that there are no two normal types of reduction as represented by "telosynaptists" and "parasynaptists." It is a matter of divergent psychology or rather cytological cults or sects. But as stated in the beginning, in the higher plants at least, when the reduction is normal, there is both telosynapsis and a real parasynapsis. There are no two types in Lilium for example; the one group of priests or the other is worshiping a false god. According to the Morgan scheme of crossing over, a very definite telosynapsis is demanded if the scheme is to work; for in the following parasynapsis the corresponding parts of the chromosomes must always be in juxtaposition. If the chromosomes are differentiated as to the two ends such a definite mode of telosynapsis may normally take place. But such a method of crossing over as proposed by the Morgan school of geneticists appears too impossible to be taken seriously at the present time. Crossing over can be explained on entirely different assumptions which agree much better with the cytological evidence.

In case of incomplete sexualization of the synaptic mates, parasynapsis may be absent or nearly so. This appears to be the case in the parthenogenetic diploid Leontodon (Taraxacum) as reported by Sears (14). Sears has described under the term "Ameiosis" a process in which the univalents are slow in pairing. "Synaptic pairing is end to end but takes place so slowly that spindle fibers become attached to each of the halves of each univalent instead of the univalents as a whole. In consequence the pairs come to metaphase thirteen in number, but with components still end to end and transversely oriented. . . . The division is qualitative, if ordinary canons be right." Here it is evident that chromosomes in synapsis may begin to lose their primary sexual states before synapsis is complete. In extreme cases synapsis might become so intense and be so prolonged that non-disjunction would result.

That partial loss of the property of sexualization of the chromosomes in reduction may be an important cause in the increase of chromosome numbers is strongly indicated by the discoveries of Longley and Darrow (5) in raspberries. They found that all the raspberries studied by them can be separated into two groups; those with seven haploid chromosomes and those with more than seven. Furthermore, they found that the typical species with seven haploid chromosomes have their somatic univalents pairing very promptly in the prophase of the first reduction division and that these bivalent chromosomes divide regularly and promptly in both the first and second divisions. Sometimes however, in rare cases, there was a little tardiness in pairing of univalent chromosomes, or occasionally a single chromosome lagged behind its associates in reaching the pole. They also found that the polyploid raspberries showed characteristic irregularities in the distribution of their chromosomes during meiosis. In these, prompt pairing of the chromosomes in reduction was absent. There were irregular distributions of the chromosomes, some of which lagged on the spindle and were extruded from the daughter nuclei. The authors believe that such behavior indicates a hybrid origin. There is probably both specific incompatibility and imperfect sexualization due to the hybrid condition of the nuclei.

There is probably no question but that incomplete sexualization of any set or of any complete complement of chromosomes,

leading to incomplete synapsis is one of the several causes of the origin of polyploid sets and complements of chromosomes.

Whether there is a partial loss of the synaptic property in certain Oenothera lamarckiana mutants which might modify the later part of the process of synaptic union and thus account for the slight discrepancy in the reduction as reported by Gates on the one hand and by Miss McAvoy for Oe. biennis and Fuchsia on the other is a question that only further, careful cytological studies can answer.

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THE DRAGONFLY, TACHOPTERYX THOREYI, RECORDED FOR OHIO, WITH NOTES ON ITS NEAR RELATIVES.

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From time to time we have reported additions to the list of Ohio dragonflies enumerated in Dr. Kellicott's paper published by the Ohio Academy of Science in March, 1899. The last published addition appeared in the *Ohio Journal of Science*, Volume XIV, page 219, and recorded the capture of anax longipes, at Sandusky, Ohio, by Mr. Rees Philpott.

An interesting addition to the known odonat fauna of the State is known to Science as Tachopteryx thoreyi Selys. Three specimens have been procured. A female was taken at Ira, Summit County, Ohio, June 20, 1921, by my daughter, Dorothy, who found it resting on the side of a building. A second female was taken in the same locality and by the same collector on July 20, of the same year. This latter specimen was first observed flying about a pool of slack water in a small creek and attempted to alight on the collector, but being prevented from doing so, came to rest on the trunk of a beech tree near by, where it was procured very easily with the aid of an insect net. On August 11, 1923, I was walking along a highway near Sugar Grove, in Fairfield County, when a male specimen was observed flying leisurely before me. It soon alighted on bare ground and I succeeded in capturing it with a net without great effort.

The species has been considered as a likely member of Ohio's fauna for a long time, for Williamson procured it in both Pennsylvania and Indiana nearly twenty-five years ago. Special significance attaches to the species, for it is considered as one of the members of a primitive group, which is supposed to have had numerous representatives in both species and individuals widely distributed over the world. More recently conditions seem to have been less favorable for their requirements for a once dominant group is now reduced to a few scattered species, apparently with a somewhat limited number of individuals belonging to each.

If all specimens of the subfamily are as easily procured as those taken in Ohio, surely they cannot be considered wary, and perhaps a suggestion is evident as to why the group is declining and possibly in danger of becoming extinct.

Tachopteryx thoreyi Selys is classified in the subfamily Petalurinæ, which includes nine known species, distributed in five genera.

PETALURA Leach is known only from Australia and contains three species, *gigantea* Leach, *ingentissima* Tillyard, and *pulcherrima* Tillyard. The second species has been mentioned as the largest dragonfly in the world, and if it does not hold this record, it approaches it closely, for some specimens have an expanse of six and one-half inches and a total length of five inches.

UROPETALA Selys is peculiar to New Zealand, so far as known, and contains two species, *carovei* White and *chiltoni* Tillyard. The species of this genus have an expanse of about four inches.

TACHOPTERYX Selys, as now restricted, contains only one species, *thoreyi* Selys. It is not known to occur beyond the limits of the United States, but has been collected in New York, Pennsylvania, Maryland, Kentucky, Indiana, Ohio, North Carolina, Texas and Florida.

TANYPTERYX Kennedy is a generic name proposed a few years ago in a valuable paper entitled "Notes on the Life History and Ecology of the Dragonflies (Odonata) of Central California and Nevada," by Dr. C. H. Kennedy, for the reception of *hageni* Selys from Western United States, and *pryeri* Selys from Japan.

The type locality for *hageni* is Nevada, but specimens are known also from Washington and California.

PHENES Rambur contains only one species, *raptur* Rambur, from Chile. Very little literature concerning this species has appeared.

The widely scattered distribution of the few existing species is advanced as one of the proofs that the Petalurinæ formerly was an important factor in the dragonfly fauna of the world, but has declined, so that the representatives of the group now known may be considered as remnants that have become pocketed in these isolated localities.

The well known authority on dragonflies, E. B. Williamson, was the first to publish regarding the metamorphosis of a

member of the subfamily. In his paper in *Entomological News*, Volume XII, page 1, he records the capture of a nymph of Tachopteryx thoreyi and gives a full description and a figure of the specimen from which an adult female was reared.

Later Dr. R. J. Tillyard, of New Zealand, formerly of Australia, made a notable contribution to the knowledge of life histories of dragonflies when he published the results of his work on Petatura gigantea in the Proceedings on the Linnaen Society of New South Wales, in 1909 and 1911. He succeeded in finding nymphs of various sizes and ages in plentiful numbers. They burrow in the mud of swamps, where but little water is standing. The burrows were observed to go down two or three feet in depth and to be connected with cross burrows in such a way as to form a complex which several nymphs use as a retreat. Tillyard concluded that these nymphs probably leave the burrows at night to procure food and possibly when they change from one instar to the next.

The latter observer in a paper in the Transactions of the New Zealand Institute for 1921 gives the reproduction of a photograph of the nymph of Uropetala carovei and a few notes concerning the species.

Previous observations have associated the species of this subfamily studied, with marshy areas where not much water stands, such as are found surrounding the outlet of springs that issue at a level somewhat higher than an adjacent stream bed, but where the flow of water is more or less retarded by the lay of the land and by the growth of vegetation and the collection of derived material. It is very likely that where such an area is available for breeding grounds, Tachopteryx thoreyi may be found flying in season in the vicinity. It is like many other species of animals with a particular habitat. They are plentiful enough when one knows where to look for them.

THE GENUS DEBARYA.

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The taxonomic history of the *Zygnemales* is characterized by more, or less, futile attempts to use the chromatophores, the various types of conjugation and reproduction, the characters of the spores, or the methods of gametè formation as the basis of classification. The splitters have had their innings and have postulated numerous genera which later on had to be abandoned because of the discovery of new species which were intermediate, or which exhibited two or more conflicting generic characters. The history of the genus *Mougeotia* is a striking example, which as now understood includes *Mesocarpus*, *Craterospermum*, *Plagiospermum*, *Staurospermum* and *Gonatonema*.

The various groupings into families and subfamilies have been equally various and futile, and the best scheme at the present time seems to be to consider the *Zygnemales* as an Order of the *Akontæ* co-ordinate with the *Desmidiales*. The Order Zygnemales consists of a single family: the Zygnemaceæ. This family includes 6 genera: *Debarya*, *Mougeotia*, *Temnogametum*, *Pleurodiscus*, *Zygnema*, and *Spirogyra*. Altogether about 200 valid species have been described. Under this arrangement the natural relationships of the species and genera are more readily visualized, and certainly less obscured than by the use of a larger number of arbitrary subdivisions.

The genus *Debarya* was founded by Wittrock in 1872 to more definitely classify the "Mougeotia glyptosperma" described and figured by De Bary in 1858. There are two outstanding features of this alga: (1) the form of the zygospore is absolutely unique among the known *Zygnemales;* and (2) as the gametes form and contract toward the conjugating tubes pectic compounds and cellulose accumulate within the gametangia replacing them. The chromatophore is quite similar to that of *Mougeotia*. In 1894 Palla described "Mougeotiopsis calospora" as a new genus and species which resembles *Debarya* in the solidification of the gametangia but which differs from *Debarya* in the apparent absence of pyrenoids. In 1898 W. and

G. S. West questioned the validity of this observation and of its use as a generic character, and in 1900 renamed it *Debarya calospora* based on material collected in Yorkshire which had pyrenoids. In 1897 the Wests also transferred to this genus the "Zygogonium læve," described by Kuetzing in 1849, as *Debarya lævis*. In both these species the cell shape is more that of a *Zygnema* than of a *Mougeotia*, and the chromatophores are rather indefinite structures with two, three, or several pyrenoids only remotely resembling *Mougeotia*. In 1903 the Wests added a fourth species, *Debarya desmidioides* with short cells and indefinite rod-shaped chromatophores, each with two distinct pyrenoids.

Debarya americana was described by the writer in 1915. This species has cells and chromatophores intermediate between *Mougeotia* and *Zygnema*. The chromatophores are usually definite and platelike with two pyrenoids but at the time of conjugation often thickened around each pyrenoid and more or less dumbbell-shaped. In the latter condition these chromatophores are quite similar to those of *Zygnema vaucherii* Ag. var. *stagnale* (Hassall) Kirchner.

At the same time *Debarya decussata* was described in which the vegetative cells are indistinguishable from those of *Zygnema*. The reproductive structures, however, both zygospores and aplanospores, are entirely different from those of *Zygnema decussata* which it otherwise closely resembles. In addition to structural differences this alga has the characteristic secretion of pectic material and cellulose occupying the gametangia, or the sporangium, and adhering to the mature spore.

The zygospores and method of conjugation of *Zygnema spirale* described by Fritsch from South Africa are quite similar to those of *Debarya decussata* even to the tendency toward spiral twisting of the conjugated filaments. This form must therefore be transferred to *Debarya* if we accept the accumulation of pectic compounds and cellulose in the gametangia as the most important charactertisic of this genus, and are willing to concede that the chromatophores are of secondary importance. We must not overlook the fact that in the present genus *Mougeotia* there are not less than four forms of chromatophores (1) the single axile plate (most species), (2) the rod-shaped (*M. capucina*), (3) two parallel platelike chromatophores with the nucleus between (frequent in *M. robusta*), and (4) two axile

plates one in either half of the cell with the nucleus between (*M. punctata* mss.).

In 1895 Hallas described a peculiar conjugate under the name *Zygnema reticulata* which produced only aplanospores, whose vegetative cells in part resemble *Zygnema* and in part (according to her figures) *Mougeotia* with several pyrenoids in a chain. The aplanospores resemble those of *Debarya decussata* in having the sporogenous cells solid instead of empty as in *Zygnema*.

Recently Fritsch has figured and discussed a quite similar form from South Africa which reproduces by akinetes. Its vegetative cells in some cases resemble those of *Zygnema*, sometimes have four stellate chromatophores, and sometimes 2 or 4 greatly elongated chromatophores. Through the kindness of Miss E. Stephens of Capetown I have examined some of this material, and also a later collection of this same alga from another locality in which aplanospores were present. Some of the akinetes and aplanospores are shown in Figures 38 to 44. For the reasons stated above I believe this form is best classified as a *Debarya*.

Finally we must not overlook *Debarya africana* G. S. West in which the secretion from the gametes occurs only during the initial stages of conjugation. This is the only species in which it does not continue until the fusion of the gametes.

Clearly all the species here grouped under *Debarya* have (1) the common habit of secreting pectic material and cellulose during the formation and migration of the gametes, and (2) the whole of the contents of the conjugating cells enters into the formation of the zygospore. The first of these characteristics distinguishes this genus from both *Mougeotia* and *Zygnema*. The second separates it clearly from *Mougeotia*.

In several species of *Mougeotia*, for example *M. uberosperma*, *M. capucina*, and *M. tropica*, there are solid processes extending into the sporogenous cells from the zygospores, or the aplanospores. These are not formed, as in *Debarya* during the development and migration of the gametes, but immediately after the union of the gametes. Consequently these species differ from those here placed in *Debarya* in that the secretion of solid material follows conjugation and a part of the contents of the conjugating cells remains in the otherwise empty gametangia.

In view of all these facts the genus *Debarya* may be defined as follows:

Debarya Wittrock 1872.

Wittrock, V. B. 1872. Om Gotlands och Oelands Sotvattensalger Bih. Kgl. Swensk. Vet-Akad. Handl. Vol. 1, No. 1; Transeau, E. N. 1915. Notes on the Zygnemales. Ohio Jour. Sci., Vol. 16, p. 20.

Vegetative cells cylindrical or slightly constricted at the ends, varying from 1 to 16 diameters in length. The chromatophores vary from an axile plate with 2 or several pyrenoids, to an axile two lobed body with 2 pyrenoids, and finally to two radiate or elongate bodies each with one or several pyrenoids. Reproduction by zygospores *formed of the complete contents* of the gametangia and occupying the conjugating tube. The zygospores are not *separated from the gametangia by cross walls.* In the process of conjugation, as the gametes form and pass into the conjugating tube, a secretion of pectic material and cellulose occurs which either greatly thickens the gametangium walls or fills the gametangia. In Debarya more than in any of the genera of the *Zygnemaceæ* the spores vary in form and disposition of their cell walls. Aplanospores having walls similar to those of the zygospores occupy only a part of the sporogenous cell, the remainder being filled with pectic material and cellulose. Parthenospores and akinetes occur not infrequently in several of the species.

Key to the Species of Debarya.

1. Forming aplanospores.....11
1. Forming zygospores.....2
2. Veg. cells usually with more than 2 pyrenoids in an axile chrom.....3
2. Veg. cells with *only 2* pyrenoids in an axile chromatophore..... 7
2. Veg. cells with 2 or more *radiate chromatophores*.....9
3. Diam. vegetative cells more than 18 microns.....4
3. Diam. vegetative cells less than 18 microns.....6
4. Spore wall smooth, spores extending beyond the tube.....5
4. Spore wall scrobiculate, spores contained in the tube.....3-D. lævis
5. Zygospores 50–56μ in diameter.....1-D. africana
5. Zygospores 30–40μ in diamtere.....2-D. immersa
6. Spores quadrangular, smooth.....4-D. hardyi
6. Spores discoid with 3 prominent encircling ridges.....5-D. glyptosperma
6. Spores globose, or subglobose, pitted.....6-D. calospora
7. Spores compressed ovoid, scrobiculate.....7-D. americana
7. Spores quadrangular ovoid smooth.....8
8. Diam. veg. cells 7.7–8.6μ.....8-D. desmidioides
8. Diam. veg. cells 10–12μ.....9-D. cruciata
9. Veg. cells with 2 radiate chromatophores.....10
9. Veg. cells with 2–7 radiate chromatophores.....10-D. reticulata
10. Spores 30–36μ x 48–54μ.....11-D. spiralis
10. Spores 24–30μ x 30–48μ.....12-D. decussata
11. Diam. veg. cells 18–30μ, spores symmetrically ovoid.....10-D. reticulata
11. Diam. veg. cells 16–20μ, spores unilaterally ovoid.....12-D. decussata
11. Diam. veg. cells 36–42μ, spores symmetrically ovoid.....13-D. pectinata

1. *D. africana* G. S. West. 1907. Jour. Linn. Soc. Bot Vol. 38, p. 104; pl. 5, fig. 3. Vegetative cells 23–26μ x 90–200μ chromatophores with 5–8 pyrenoids; zygospores globose-ovoid, 50–56μ in diameter,

filling the conjugating tube and extending nearly to the opposite thickened walls of the gametangia; spore wall smooth. Fig. 1. Nyassa, Africa.

This is the only species of the genus in which the gametangia do not become filled with pectic material and cellulose, as the gametes move into the tube during conjugation. There is a thickening of the walls, however, except at the center of each transverse wall.

2. *D. lævis* (Kuetz.) W. & G. S. West. 1897. Jour. Roy. Micros. Soc. p. 476; Mougeotia lævis Archer, Jour. Micros. Soc. 8: 65. 1869; Zygogonium læve Kuetzing, Spec. Alg. p. 447, 1849; G. M. Smith, Wis. Acad. Sci. Art. & Lett. 18 : 561, 1916; G. S. West, British Freshwater Algæ, p. 128, Fig. 46, C-E, 1904.

Vegetative cells 20–26μ x 20–100μ, chromatophores with 2–4 pyrenoids; fertile cells elongated; zygospores filling the conjugating tube ellipsoid to ovoid 20–36μ x 42–50μ, median spore wall scrobiculate. Fig. 18. Europe; Wisconsin.

3. *D. immersa* W. West. 1902. Jour. Bot. 40 : 144; 41 : 58. Vegetative cells 20–24μ x 20–75μ, zygospores ovoid to subglobose, 30–40μ x 30–48μ, filling the tube and extending into the gametangia, median wall smooth. Not figured. India.

4. *D. calospora* (Palla) W. & G. S. West. 1898. Annals of Bot. 12 : 49; Jour. Bot. 38 : 289; Mougeotiopsis calospora Palla, Berichte Deutsch. Bot. Gesellsch. 12 : p. 228, 1894; G. S. West, British Freshwater Algæ, p. 128, Fig. 46, B, 1904. Vegetative cells 11–18μ x 11–72μ, chromatophores with several pyrenoids more or less distinct; zygospores ovoid to globose, 18–26μ in diameter; median wall pitted, brown. Fig. 3. Europe.

5. *D. americana* Transeau. 1915. Ohio Jour. Sci. 16 : 18. Vegetative cells 9–12μ x 27–120μ, chromatophore an axile plate with two pyrenoids; fertile cells 10–14μ x 75–180μ; zygospores ovoid to quadrate ovoid 20–40μ x 30–40μ; parthenospores 15–20μ x 20–30μ, unilaterally ellipsoid with retuse ends, median spore wall minutely and irregularly verrucose, yellow-brown. Figs. 6, 7, 16 and 17. Ontario, Michigan.

6. *D. decussata* Transeau. 1915. Ohio Jour. Sci. 16 : 19. Vegetative cells 16–20μ x 24–50μ chromatophores as in *Zygnema* with two pyrenoids; zygospores ovoid to quadrate-ovoid, and irregular, 24–30μ x 30–48μ, angles rounded, retuse, or produced; aplanospores unilaterally ovoid, the plane of the convex side changes in successive cells, 17–25μ x 20–40μ parthenospores 15–20μ x 20–30μ, median wall in all the spores scobiculate; akinetes with smooth heavy walls, 18–20μ x 20–36μ. Fig. 28–33. Illinois, Michigan, Pennsylvania, Iowa, Ontario. In some collections only aplanospores occur, in others only zygospores. A majority of the collections contain both.

7. *D. hardyi* G. S. West. 1909. Jour. Linn. Soc. Bot. 39 : 51, Pl. 2; Algæ, Camb. Bot. Handbooks Vol. 1, p. 341, Fig. 213. 1916. Vegetative cells 6.4—7.5μ x 57–120μ, chromatophore an axile plate with 2–4 pyrenoids; zygospores quadrangular with straight or concave sides, angles retuse, 22.5–27μ. Figs. 2, 11, and 12. Spores possibly not mature. Australia.

8. *D. cruciata* Price. 1911. New Phytologist 10 : 87; 11 : 60. Vegetative cells 10–12μ x 30–60μ, chromatophore with 2 pyrenoids; conjugation between cells usually after dissociation of the filaments; zygospores quadrangular with concave or rarely straight sides, angles produced or slightly concave, 20–24μ x 28–32μ, median wall smooth. Fig. 13, 14 and 15. Spores possibly not mature. England.

9. *D. desmidioides* W. & G. S. West. 1903. Jour. Bot. 41 : 7, Pl. 446; G. S. West, Algæ Camb. Bot. Handbooks Vol. 1, p. 341, Fg. 213. 1916. Vegetative cells 7.7–8.6μ x 19–56μ constricted at the ends, chromatophore an axile plate with 2 pyrenoids; conjugation between free cells after dissociation of the filaments; zygospores 20–24μ x 22–30μ, median wall smooth. Figs. 8, 9, and 10. Spores possibly not mature. England.

10. *D. glyptosperma* (De Bary) Wittrock. 1872. K. Svenska Vet. Akad-Handl. 1 : 35; Conjug. p. 78, T 8. Fig. 20–25; Mougeotia glyptosperma De Bary, A., Conjugatæ p. 78, 1858; G. S. West, British Freshwater Algæ, p. 128, Fig. 46, A. 1904.

Vegetative cells 9–16μ x 50–200μ, chromatophore an axile plate with several pyrenoids; zygospores lenticular to compressed ovoid, with median wall marked by three parallel ridges and polar projections, connected by radial lines; shorter axis 30–48μ, longer 42–72μ. Fig. 4. Europe; N. Zealand, New Hampshire, Massachusetts, Minnesota, Florida, Michigan.

Var. formosa Transeau. 1915. Ohio Jour. Sci. 16 : 18. Vegetative cells 7.5–9μ in diameter; zygospores 24–30μ x 30–42μ, median wall steel blue; otherwise like the type. California.

11. *D. reticulata* (Hallas) Transeau. 1915. Ohio Jour. Sci. 16 : 20; Zygnema reticulata Hallas. E., 20 : 1–16. 1895.

Vegetative cells 18–30μ x 35–100μ, with 2–7 chromatophores resembling those of *Zygnema*; zygospores unknown; sporogenous cells up to 240μ in length, inflated toward the middle, aplanospores subglobose to ellipsoid up to 35μ in diameter, median wall yellow, scrobiculate, and irregularly reticulate. Spores give rise to 1, 2, or 3 filaments on germination. Fig. 19–27. Europe.

12. *D. spiralis* (Fritsch) Comb. nov. Zygnema spiralis Fritsch, F. E., Annals South Africa Museum 9 : 564. 1918.

Vegetative cells 18–25μ x 40–130μ with two stellate chromatophores; zygospores quadrately ovoid formed in the greatly enlarged conjugating tube but extending into the gametangia, 48–54μ x 30–36μ. Mature spores lacking so that the character of the median wall is unknown. Figs. 34–37. South Africa.

13. *D. pectinata* (Fritsch) Comb. nov. Zygnema pectinatum, Fritsch, F. E., Roy. Soc. S. Africa 9 : 55. 1921.

Vegetative cells 36–42μ x 83–200μ with two stellate, or greatly elongated stellate chromatophores each with one pyrenoid, or more rarely 2 or 3 pyrenoids; zygospores unknown; akinetes swollen toward the middle to 80μ, with walls 6–8μ thick, sometimes obliquely ventricose alternating in successive cells; aplanospores 70–94μ x 100–128μ ellipsoid, or with polar thickenings, outer wall 4–8μ thick smooth, median wall irregularly tuberculate. Figs. 38–44. Kentani District, South Africa.

EXPLANATION OF FIGURES.

Plate I.

Fig. 1. *Debarya africana*, showing slight thickening of walls and pits in the centers of the cross walls. After G. S. West.

Figs. 2, 11, 12. *Debarya hardyi*, showing early stage of conjugation and immature zygospores. After G. S. West.

Fig. 3. *Debarya calospora*, vegetative cells and mature spores. After G. S. West.

Fig. 5. *Debarya glyptosperma*, mature spores. Drawn from material collected near Boston, Mass.

Figs. 6, 7, 16, 17. *Debarya americana*, mature spores and vegetative cell, from material collected by A. B. Klugh, Kingston, Ontario.

Figs. 8, 9, 10. *Debarya desmidiodes*, vegetative filament and spores. After G. S. West.

Figs. 13, 14, 15. *Debarya cruciata*, conjugating cells and immature zygospores. After Price.

Fig. 18. *Debarya lævis*, vegetative cell and mature zygospores. After G. S. West.

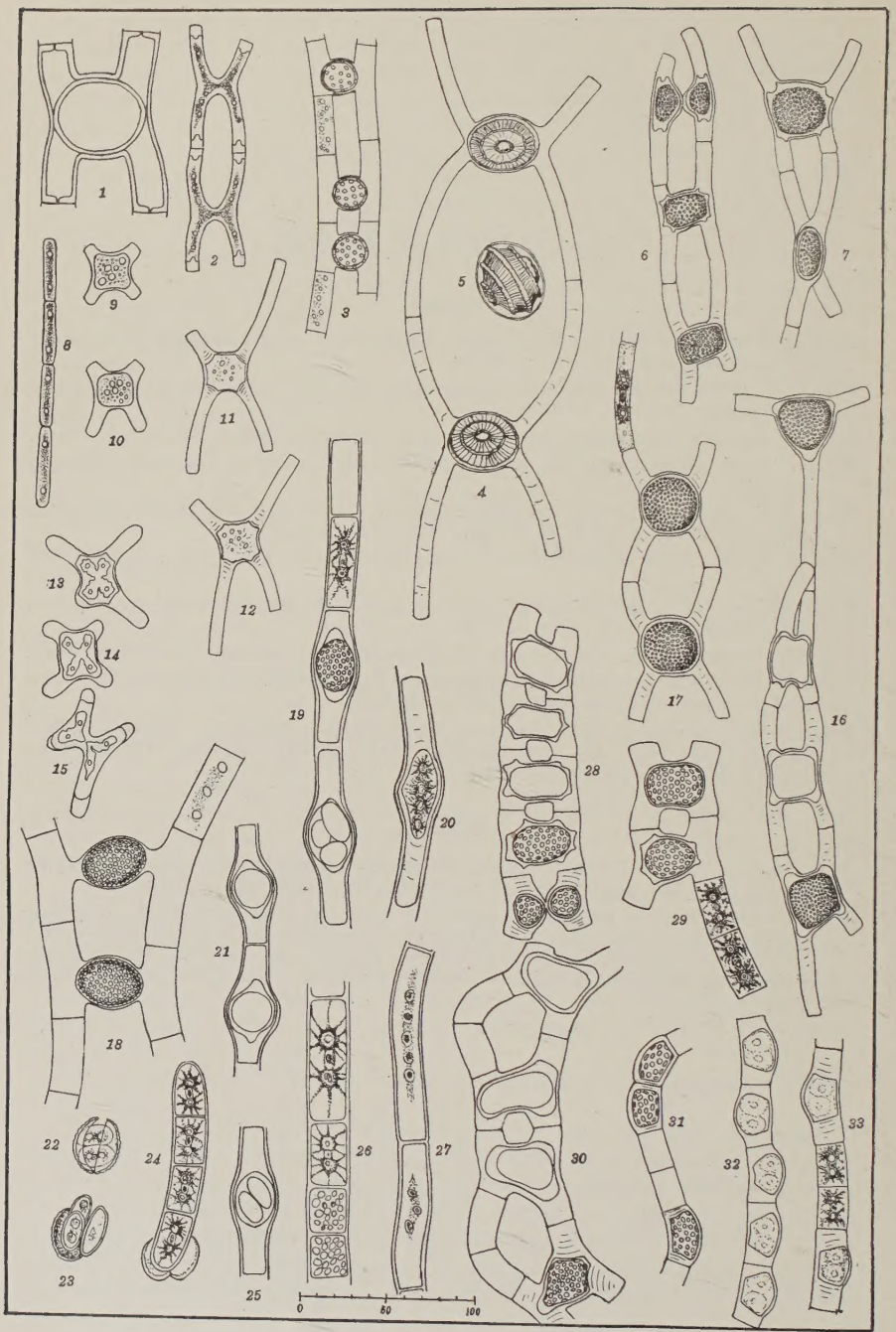
Figs. 19–27. *Debarya reticulata*, vegetative cells, aplanospores, akinete, (Fig. 20), and germinating aplanospores. After Hallas.

Figs. 28–33. *Debarya decussata*, vegetative cells, zygospores, parthenospores aplanospores (Fig. 31), and akinetes (Figs. 32–33). Drawn from material collected at Charleston, Illinois.

Plate II.

Figs. 34–36. *Debarya spiralis*, vegetative cells, conjugating cells, immature zygospores (Fig. 37), zygospore side view (Fig. 35). After F. E. Fritsch.

Figs. 38–44. *Debarya pectinata*, vegetative cells showing variety of chromatophores, akinete (Fig. 40), and aplanospores probably not completely matured. Drawn from material collected by H. A. Pocock, Oct. 23, 1923, Cedar Mountains, Clan William, in shallow stream. For other figures see paper by F. E. Fritsch.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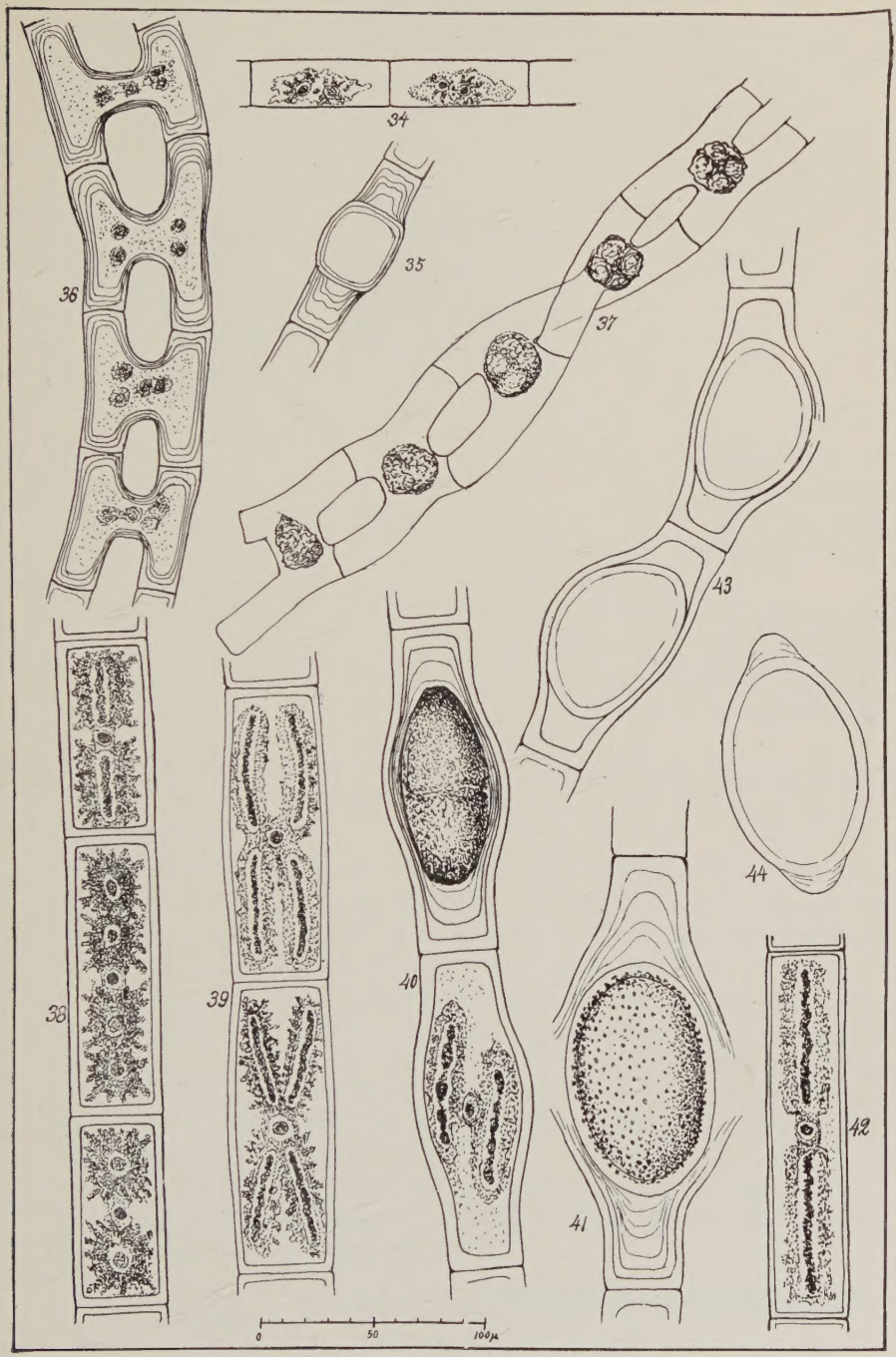
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